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DESIGNING FOR A RESILIENT WATERFRONT

Lauren Festa

Thesis Preparation Fall 2014

Advisor: Julia Czerniak

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Contention

The synthesis of architecture and landscape as a landform building, integrated with soft infrastructure systems, can enhance the resilience of an urban waterfront in east coast estuary cities.

Water has historically been managed through hard infrastructure systems to control sea level rise and to respect the property lines and edges we have constructed and adapted to. Designers from the disciplines of architecture, landscape design, and infrastructure work with these constructed or labeled edges.¹ In an effort to control storm surge and sea level rise, infrastructure has often been designed with the main criteria being economic and technical efficiency. Water, however, has little respect for boundaries and the infrastructure systems meant to control it. Therefore, the infrastructure systems have to perform by engaging with the landscape and the architecture threatened by sea level rise.

As Mathur states, “the exploration of the reduction of barriers between disciplines allows for an improved response to the environmental problems at both global and local scales, making the exploration of terrain and its relation to water and the built environment critically important.”² With this integration of architecture, landscape, and soft infrastructure systems, new approaches of design can emerge that create resilient waterfronts protecting both the social and environmental vulnerabilities of sea level rise. The project I am proposing, located in the urban estuary of Boston, is to rethink how the disciplines can come together to form resilient architecture.

The site of East Boston is highly susceptible to flooding from sea level rise, and is a waterfront site to demonstrate the integration of these three disciplines that make up the urban fabric.

By integrating these disciplines and preparing for the vulnerabilities presented with sea level rise rather than designing against it, the project will use soft infrastructure systems to create a more environmental, technical, and economically resilient waterfront development. The threat of rising sea level will become the framework for a flexible and holistic design between architecture, landscape, and soft infrastructure. By arraying the activities of recreation, ecology, and urban development along the waterfront and combining these design strategies with a soft infrastructure system, the coastline of East Boston has the potential to become a precedent for other urban waterfronts vulnerable to sea level rise. By rethinking the division between landscape and infrastructure to form a soft infrastructure system, solutions can emerge for the assimilation of sea level rise.

Notes:

¹ Mathur, Anuradha. *Design in the Terrain of Water*. United States: Applied Research Design. 2014. Print.

² Mathur, Anuradha. *Design in the Terrain of Water*.

³ Zolli, Andrew, and Ann Marie Healy. *Resilience: Why Things Bounce Back*. New York: Simon & Schuster Paperbacks, 2013. Print.



“If we cannot control the volatile tides of change, we can learn to build better boats. We can design – and redesign – organizations, institutions and systems to better absorb disruption, operate under a wider variety of conditions, and shift more fluidly from one circumstance to the next. To do that, we need to understand the emerging field of resilience.”³

-Andrew Zolli in *Resilience: Why things Bounce Back*



CHELSEA RIVER

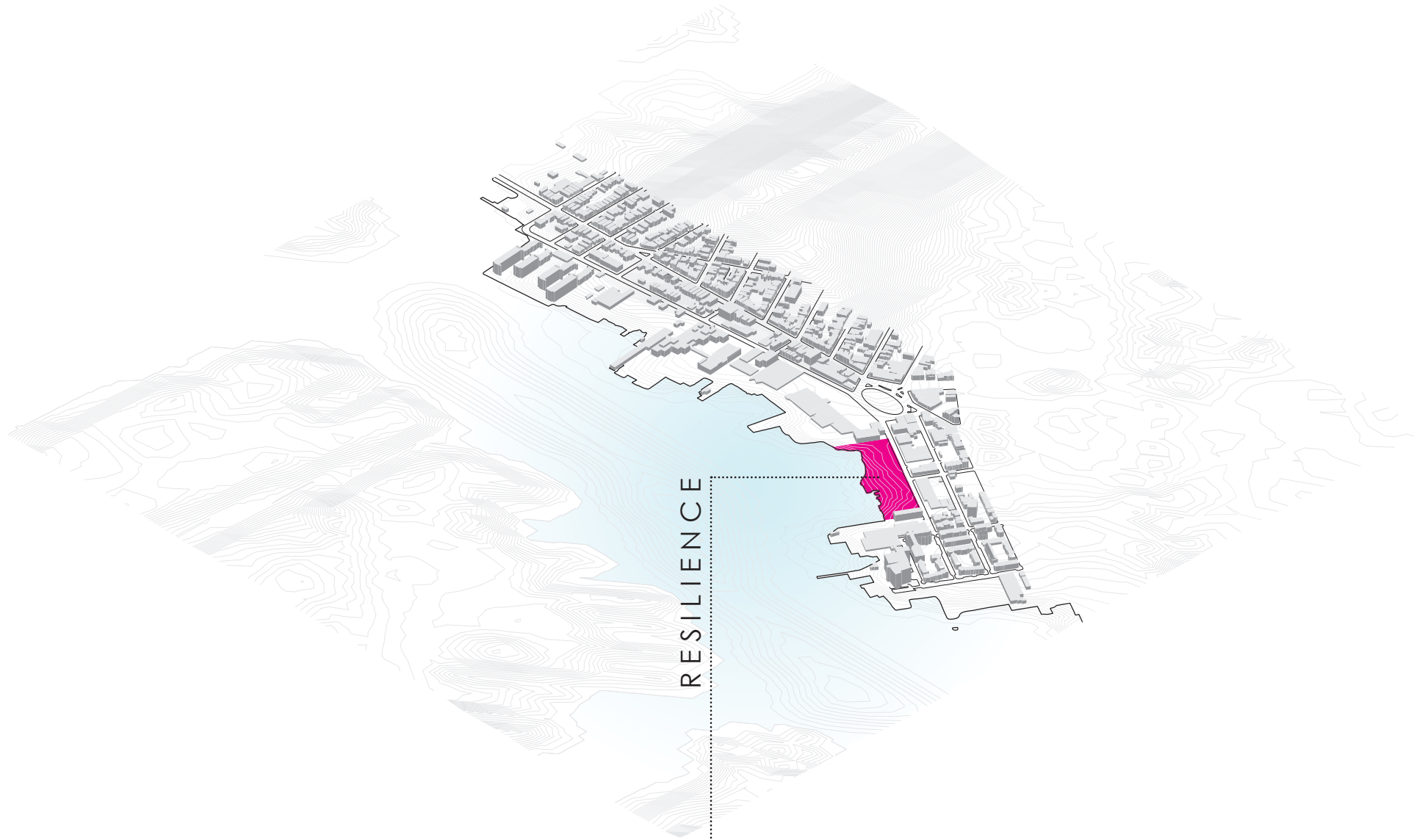
MYSTIC RIVER

CHARLESTOWN

EAST BOSTON

DOWNTOWN BOSTON

BOSTON HARBOR



RESILIENCE

Architecture

Landscape

LANDFORM BUILDING

SOFT INFRASTRUCTURE

LANDFORM BUILDING

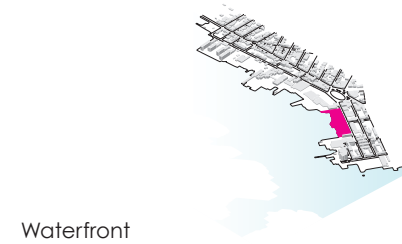
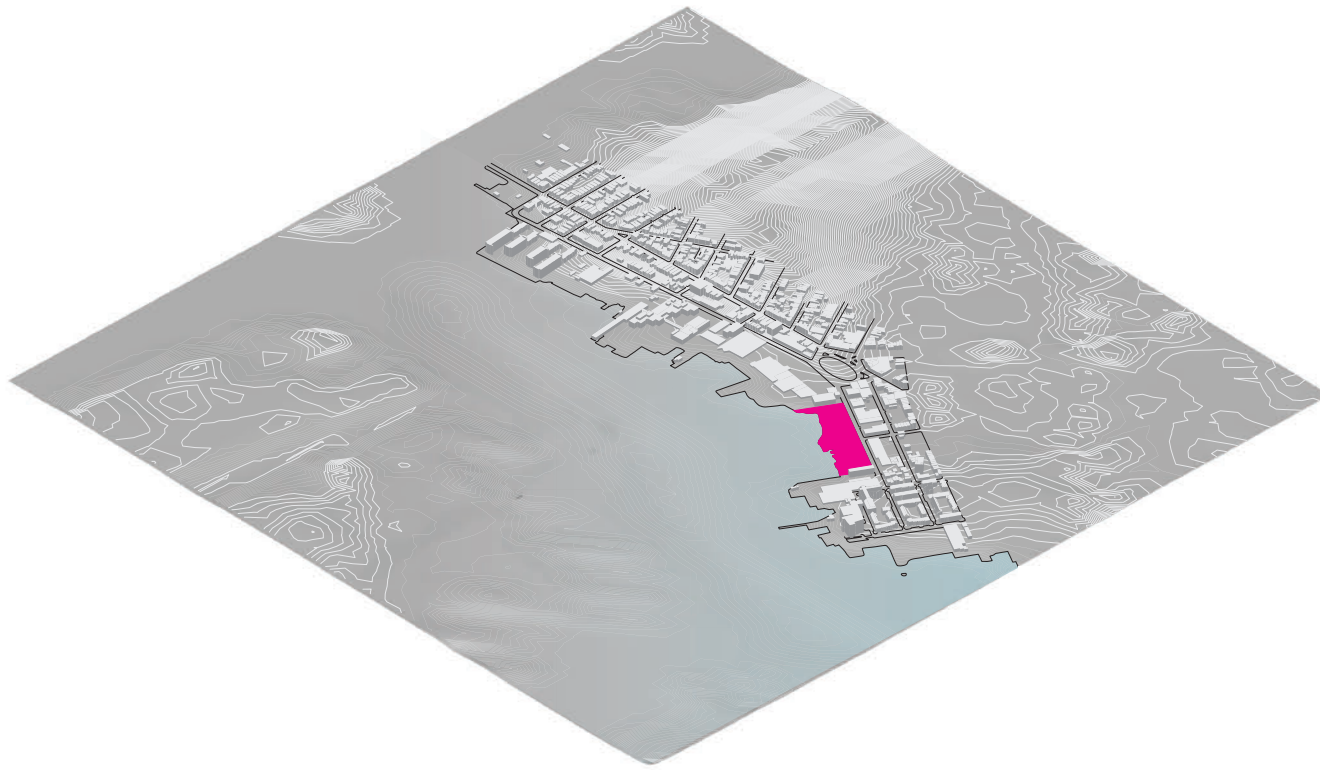
Landform Building

"For the past two decades, the dominant working metaphor in advanced architecture has been biological: a desire to make architecture more lifelike, that is to say, more fluid, adaptable, and responsive to change."¹

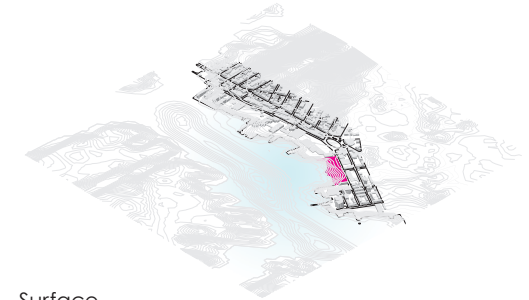
Notes:

¹ Allen, Stan. Landform building: Architecture's New Terrain. Baden, Switzerland: Lars Müller Publishers, 2011. Print.

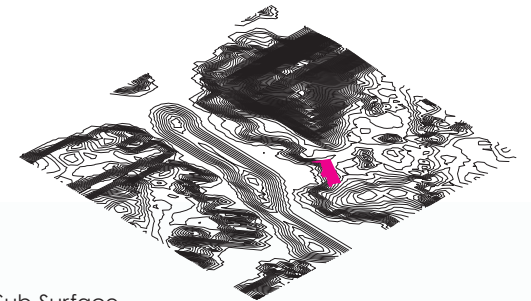
² Allen, Stan. Landform building: Architecture's New Terrain.



Waterfront



Surface



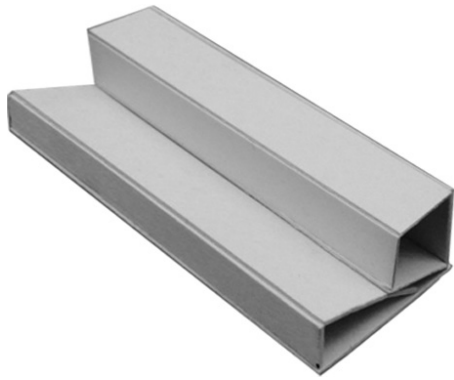
Sub-Surface



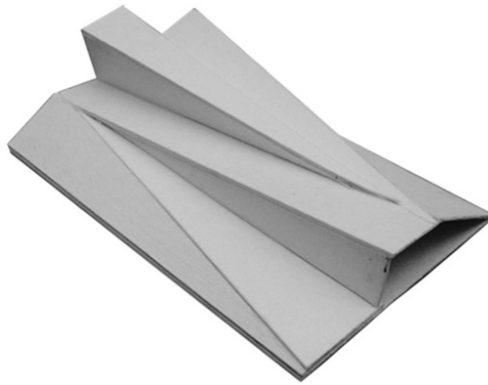
Terrain

Landform buildings hybridized with soft infrastructure systems should be layered over existing vulnerable waterfronts. Layers of surface as well as sub-surface systems combined with the architecture create a resilient and more flexible framework for the design of urban waterfronts. Stan Allen states that "the influence and manifestations of both landscape and ecology in contemporary architectural practice that is resulting in not simply a cross disciplinary phenomenon but new design techniques and formal strategies" results in landform buildings.² As architectural design continues to approach and be built upon the urban waterfront, a more seamless integration between the natural and the built must occur. Through the study of landform building, seven design characteristics of landform buildings have emerged that can be instrumental in the design of a resilient waterfront.

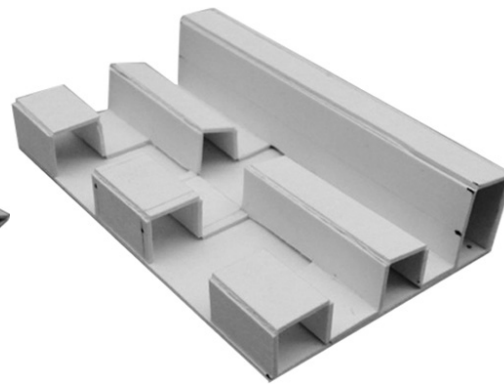
Landform Building Formal Strategies



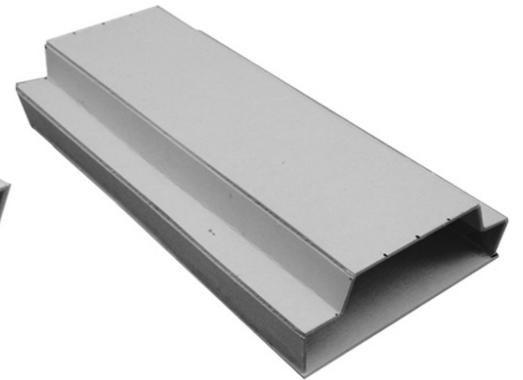
Subducting



Folding



Terracing

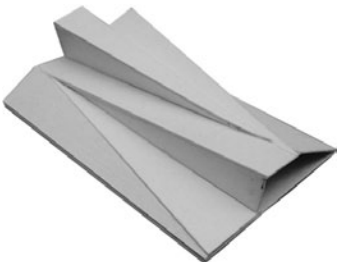


Uplifting

Soft Infrastructure Strategies



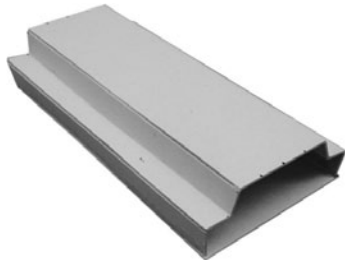
Subducting



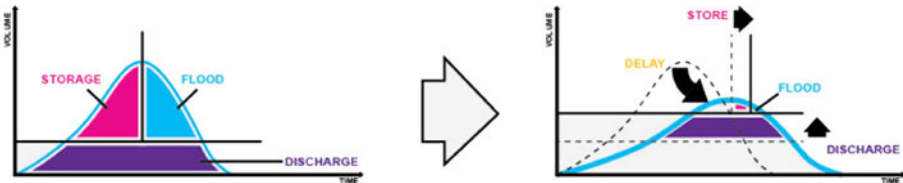
Folding



Terracing



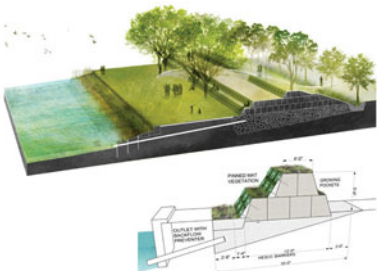
Uplifting



OMA Team Proposal for Rebuild by Design



Interboro Team Proposal for Rebuild by Design



PennDesign/OLIN Proposal for Rebuild by Design



Big Team Proposal for Rebuild by Design

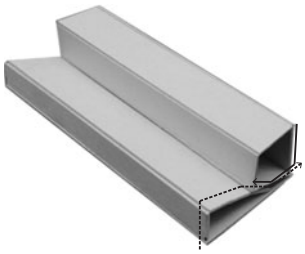
7 Characteristics of Landform Buildings

Adapted from *Landform building: Architecture's New Terrain* by Stan Allen

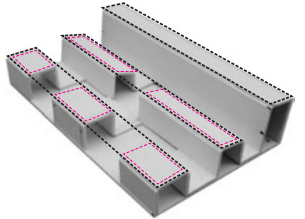
1. Landform buildings go beyond the typology of a single surface. Terrains, materials, and surface and subsurface systems should work together both horizontally and vertically to create **extended and interwoven surfaces**.
2. "Landscape and ecology, understood as dynamic, adaptive systems offer productive models to understand the complexity of the city today." A synthesis of landscape, architecture, and ecology is suggested in order to use ecology as a precedent of the **dynamic and adaptive** system that a resilient waterfront design is after.
3. Through specific building proposals, landform buildings are able to absorb and transform the new potentials of landscape and its integrated design with building. The **program, process, and affect** of the design of the landform should be recognizable over the formal similarity of landscape vs. building.
4. Landform buildings create **artificial terrains** and make use of the new programmatic possible of these terrains.
5. Landform building works with an **expanded notion of the interior**. The boundary between interior and exterior should be blurred, allowing the building and landscape to flow seamlessly together and create an immersive environment.
6. Landform buildings take advantage of the opportunities of resilience presented by the **synthesis of architecture and landscape**. Form and design of the landform rather than technology enhance the building to meet sustainability and environment performance.
7. Landform building **reworks the notion of the "object building"** and landscape field conditions, allowing for field like effects to be implemented at a building scale, promoting the integration of architecture and landscape.

Notes:

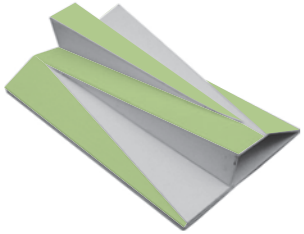
Allen, Stan. *Landform building: Architecture's New Terrain*. Baden, Switzerland: Lars Müller Publishers, 2011. Print.



extended and interwoven surfaces



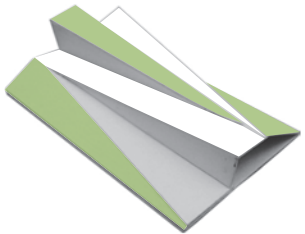
dynamic and adaptive



artificial terrains



expanded notion of the interior



synthesis of architecture and landscape



reworks the notion of the “object building”

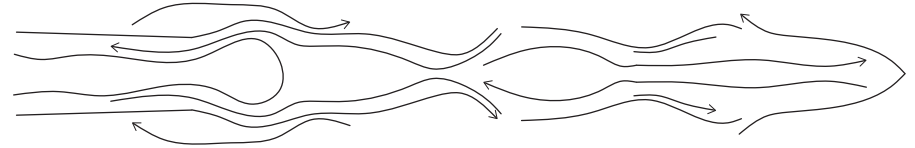
Yokohama Port Terminal

FOA

Program: a passenger cruise terminal and a mix of civic facilities

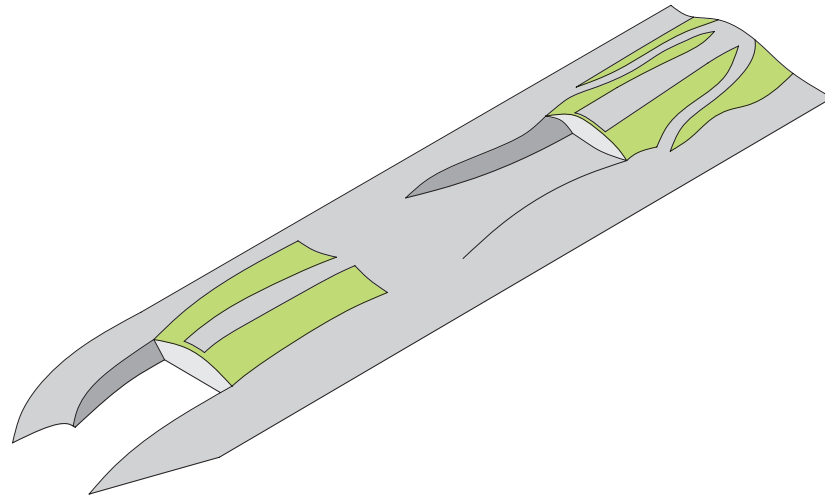
Process: the roof of the building as an open plaza and the continuation of the surrounding park surfaces created a circulation diagram that eliminates linear structure and typical directionality of pier circulation

Affect: the site presented the city with a continuous structure of open public spaces along the waterfront.



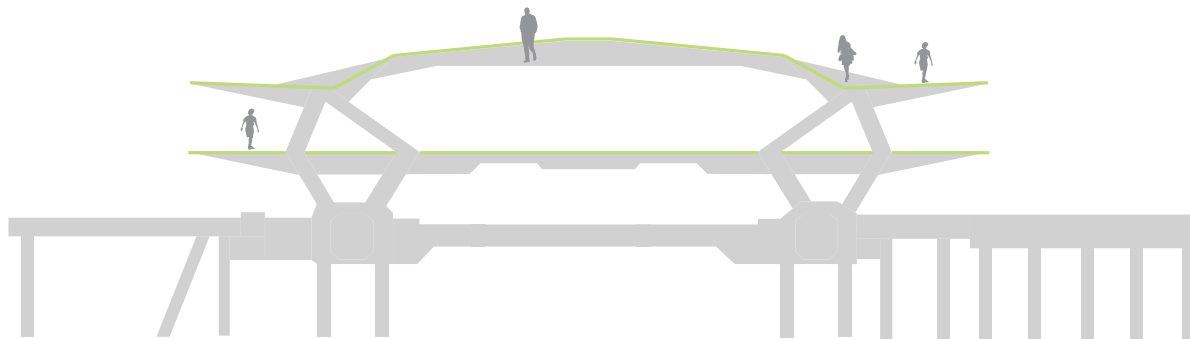
Blurred Boundary Between Interior And Exterior

The program involves managing the flows of goods and people on a system of continuous surfaces, shaping and channeling the movement of passengers to be fluid from the interior to the exterior.



Re-Working The Object Building

The site of the pier allows the project to become a continuous structure of open public space, rather than an object building.



Artificial Terrain

Operative techniques of landscape design and the programmatic effects of continuous surfaces allow the roof of the structure to be an inhabitable landscape.

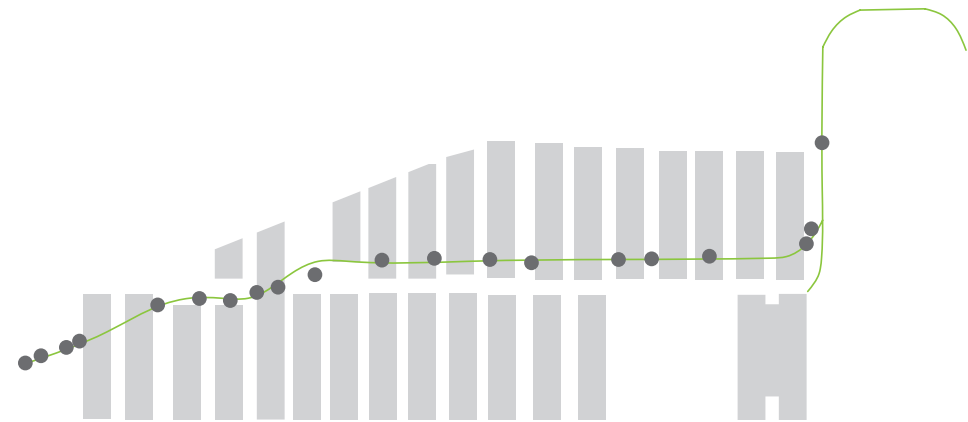
The Highline

James Corner / Diller Scofidio + Renfro

Program: an elevated, unused freight rail line transformed into a public park on Manhattan's West Side

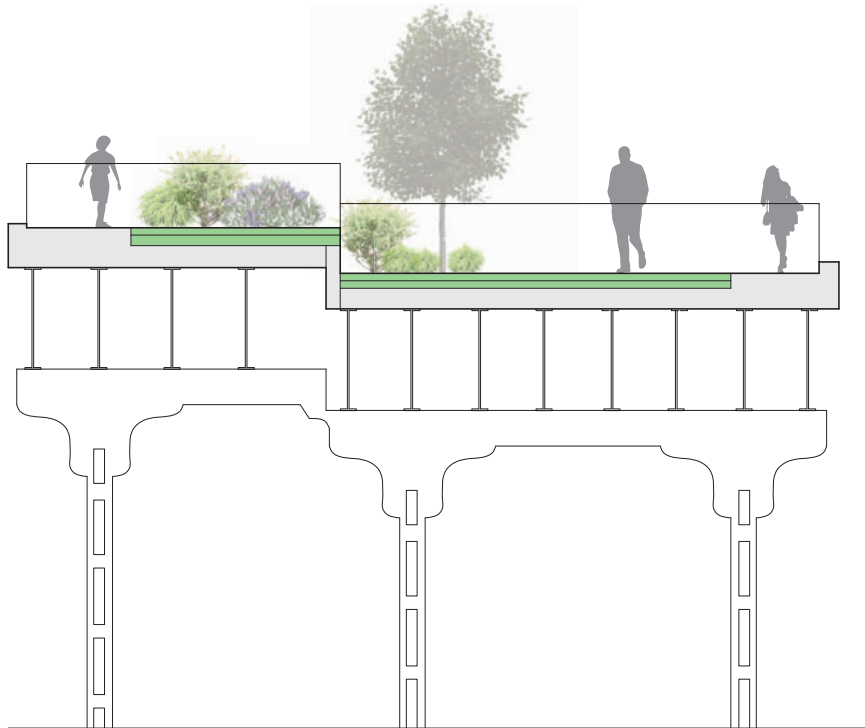
Process: the completion of the elevated landscape has worked in phases and created a network connect through the art, surrounding development, and key architectural features of the public space

Affect: community residents wanted to preserve the historic structure and were able to create one of the city's most used public spaces which that sparked the intense development of the surrounding district.



Network Connectivity

The procession along the Highline connects the people to a horizontal network of spaces, points of interest, and art and architecture surrounding and on the Highline.



Artificial Terrain

The elevated, unused piece of infrastructure was redesigned as an elevated public park through the artificial landscaping used on top of the original freight rail line.



Re-Working The Object Building

The Highline re-works the idea of the object building by emphasizing the landscape of the Highline as the object within the surrounding development.

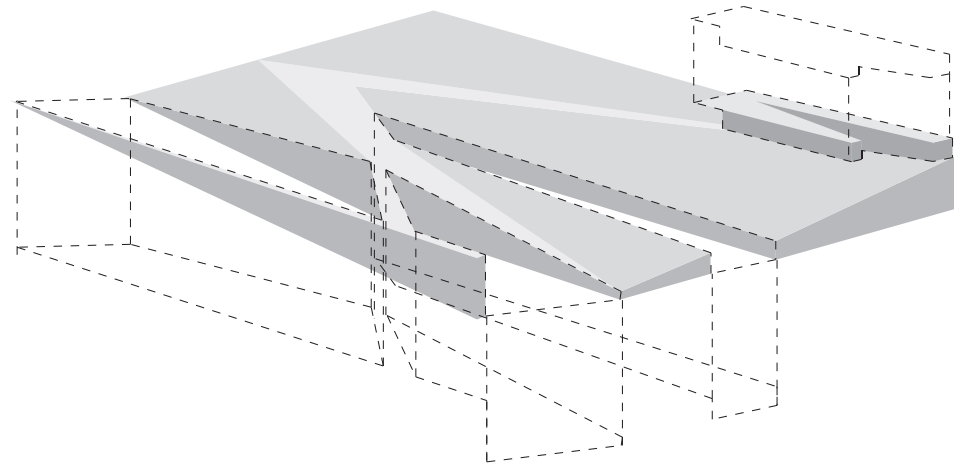
Seattle Art Museum: Olympic Sculpture Park

Weiss/Manfredi

Program: an urban sculpture park located on an industrial site at the water's edge with an exhibition pavilion to house art, performances, and educational programming.

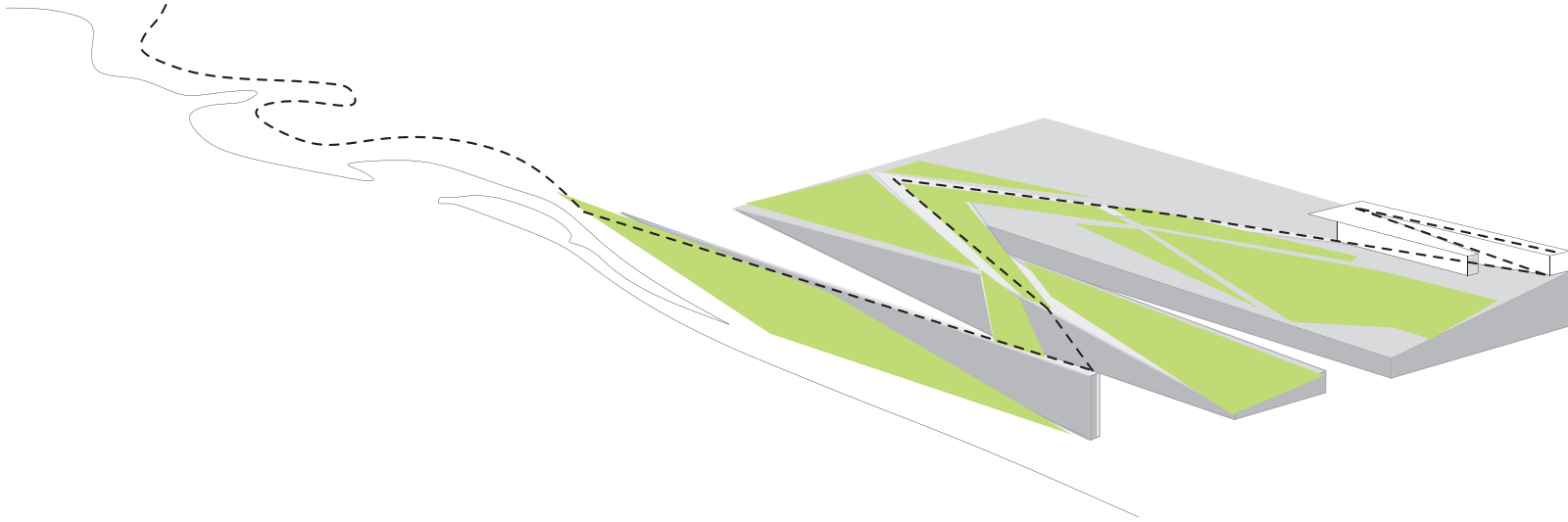
Process: The park stitches together urban fabric through a highly articulated ground plane rather than new buildings, bringing the sculptures outside of the museum walls while also bringing the park into the landscape of the city

Affect: a continuous constructed landscape for the art by extending over the existing infrastructure reconnecting the city to the waterfront.



A Blurred Boundary Between Interior And Exterior

The folded plate geometries allow for exterior spaces to be formed from the artificial landscape that eventually extend into the interior spaces of the exhibition pavilion.



Artificial Terrain

An artificial terrain is used to construct a continuous landscape that extends from the waterfront, over the existing infrastructure to the exhibition pavilion.



A Synthesis Of Architecture And Landscape

The exhibition pavilion is built seamlessly from the artificial terrain using the similar geometry of folded plates.

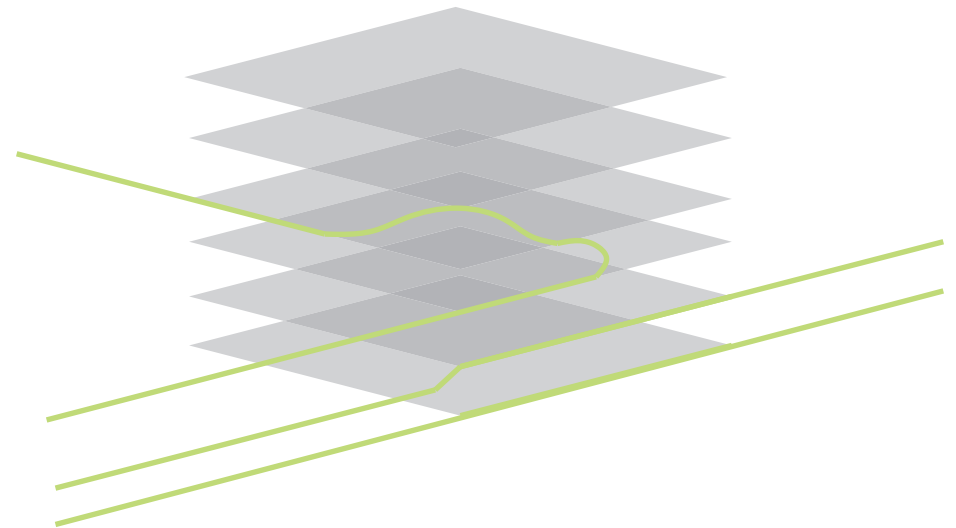
Villa VPRO

MVRDV

Program: a public broadcasting center with revolutionized work spaces

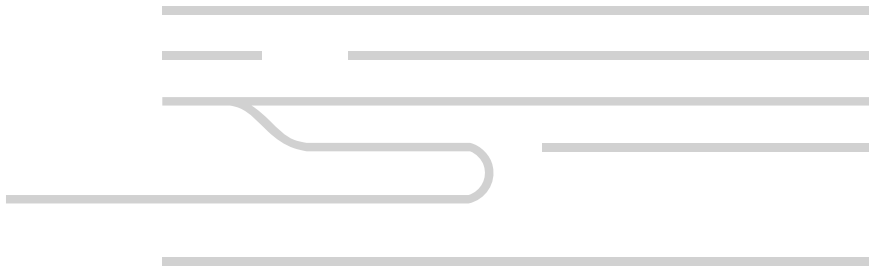
Process: The horizontal surfaces fold and warp into one another and continuity is established between separate floors. The purpose of the building is to form a hive like ecology within the horizontal section of the building over time that adapts to the work life of its inhabitants as they interact with the building.

Affect: the building constructs the site, rather than occupies it and the landscape applies process and change, over form.



Re-Working The Object Building

The cubular shaped building re-works the stereotype of the object building by the continuation of extensions of the building onto and within the site.



Network Connectivity

The horizontal surfaces fold and warp into one another and continuity is established between separate floors, allowing the building to form a network connectivity work environment.



A Synthesis Of Architecture And Ecology

The building uses the ecological precedent of a hive within the horizontal section of the building to form a dynamic and adaptive system. Over time the building adapts to the work life of its inhabitants as they interact with the building.

RESILIENCE

resilience

: the ability to become strong, healthy, or successful again after something bad happens

: the ability of something to return to its original shape after it has been pulled, stretched, pressed, bent, etc.¹

Notes:

¹ "resilience." Merriam-Webster. Merriam-Webster, n.d. Web. 5 Oct. 2014. <<http://www.merriam-webster.com/dictionary/resilience>>.

Resilient design for vulnerable waterfronts threatened by sea level rise can be accomplished through innovative planning and design and the synthesis of architecture, landscape, and soft infrastructure systems to create a more holistic approach to combat the vulnerabilities presented. In order to design for resilience, the structural and social vulnerabilities must be addressed and studied. Awareness of the vulnerabilities and assessing the strengths and potentials of the site and design is important. A resilient waterfront will be designed to be diverse and adaptive, allowing the project to operate successfully under a variety of situations and to adjust according with changing circumstances.² The connection of different fields will be used to design innovative and implementable infrastructure solutions to be layered within the architecture and landscape.³

The design for a resilient waterfront must recognize and understand the engineering principles of soft infrastructure systems and the technical and ecological goals of these systems. While there is an inherent potential of soft infrastructure to combat the vulnerabilities of sea level rise, the synthesis of these systems with both architecture and landscape offer the most potential for a holistic development of resilience. Projecting design initiatives into future concerns rather than focusing on defined and established waterfront boundaries and borders is a more effective approach to the study of resilience.⁴ Design for resilience in an estuary city needs gradients with negotiated moments rather than walls with hard edges, and more fluid occupancies over defined land uses.⁵ Because the sea is constantly changing with not a distinct boundary, a resilient and holistic design strategy demands the accommodation of the rise of sea level. Soft infrastructure systems integrated with landscape design are more capable of accomplishing these strategies over the existing infrastructure techniques often seen in waterfront communities, like sea walls. A resilient design accommodates the waterfront terrain, encourages design techniques that embrace the water rather than channel it back out to sea, and works with the gradients of an estuary city. Accommodating uncertainty is a stronger design strategy than hoping to overcome vulnerabilities by prediction and preventative methods.⁶

Infrastructure projects are generally designed with the criteria of economic and technical efficiency at the forefront. Because of this, they tend to produce large and isolated systems that prove to be unusable spaces that can cause a division between natural and built environments, specifically in the case of waterfront infrastructure. Soft infrastructure systems are currently the most adaptable solutions to managing storm defense and sea level rise along coastal urban settings. Through a balance of environmental, economic, and technical priorities, soft infrastructure systems are able to provide ecologically secure recreational and urban environments that are enriching to the coast while simultaneously creating a storm surge and sea level rise defense system.⁷



Notes:

2 "The Rockefeller Foundation." The Rockefeller Foundation. N.p., n.d. Web. 2 Oct. 2014. <<http://www.rockefellerfoundation.org/>>.

3 <http://www.rebuildbydesign.org/>

4-6 Mathur, Anuradha. Design in the Terrain of Water. 8 Mathur, Anuradha, and Dilip Da. Cunha. Soak: Mumbai in an Estuary. New Delhi: Rupa, 2009.

7 Nordenson, Guy, and N.Y. York. On the Water: Palisade Bay. Ostfildern: Hatje Cantz ; 2010. Print.

Organizations

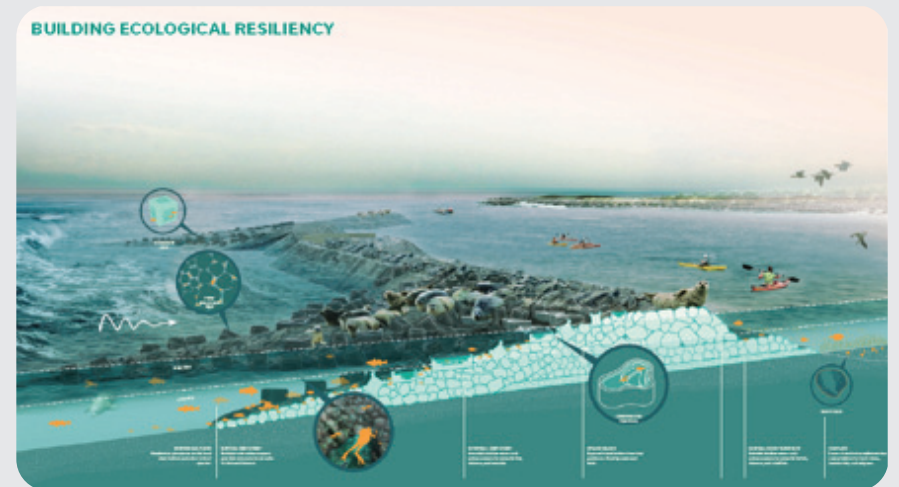
US Army Corps of Engineers

The US Army Corps of Engineers is a government organization that focuses on environmental sustainability. The USACE delivers engineering services throughout the country that are meant to strengthen the nation's security through the building and maintenance of infrastructure. The organization is highly involved in devising hurricane and storm damage reduction infrastructure that reduces risk from disasters and rising sea level. The USACE focuses on the effectiveness, safety, and economic benefits of the projects, and after Hurricane Sandy, evaluated the performance of many existing projects and determined their efficiency. Many USACE projects implement the use of seawalls, levees and closure gates to prevent damage to waterfront sites. Beach fill, dunes, and revetments are also implemented and have been beneficial in reducing coastal flood risks.¹



Rebuild by Design

Rebuild by Design is a competition founded in response to the immense damage and devastation caused by Hurricane Sandy. Initiated by the US Department of Housing and Urban Development and the Presidential Hurricane Sandy Rebuilding Task Force, the competition works to establish innovative solutions to protect vulnerable U.S. waterfront cities against severe weather and future sea level uncertainties. Rebuild by Design has been able to connect designers, researchers and businesses in order to redevelop waterfront communities in a more ecologically and environmental way with safety as a main priority. The design competition differentiates itself by encouraging ambitious, yet realistic developments focused on resilience on every level.²



Notes:

¹ US Army Corps of Engineers. "Hurricane Sandy Coastal Projects." <i>Performance Evaluation Study</i>. N.p., n.d. Web. 11 Sept. 2013. <http://www.nan.usace.army.mil/Portals/37/docs/civilworks/SandyFiles/USACE_Post-Sandy_Coastal_Projects_Performance_Evaluation_Study.pdf>.

² "Working Together to Build a More Resilient Region." Rebuild by Design Working Together to Build a More Resilient Region Comments. N.p., n.d. Web. 16 Sept. 2014. <<http://www.rebuildbydesign.org/>>.

Hurricane Sandy Rebuilding Task Force

The Hurricane Sandy Rebuilding Task Force was implemented in 2012 by President Obama after the damages incurred by Hurricane Sandy. The purpose of the task force was to provide appropriate resources to improve upon the waterfront region damaged by the Hurricane in regards to its health, resilience, and prosperity. The Hurricane Sandy Rebuilding Task force builds upon lessons learned from previous disasters while rebuilding and revitalizing and works with federal, state, and local officials as well as private, non-profit, philanthropic, and community organizations. From this task force many other organizations and programs have developed, such as Rebuild By Design, and people from various disciplines have come together in the design of resilient waterfronts.¹



The Rockefeller Foundation

The Rockefeller Foundation is more than 100 years old and operates within the United States and around the world to promote the well-being of humanity. The Foundation focuses on advancing economies to expand opportunities that allow for more broadly shared prosperity as well as building resilience to have people, communities, and institutions able to emerge stronger from shocks and stresses and to be better prepared for and able to withstand them. The foundation has pioneered other programs, such as 100 Resilient Cities, which is dedicated to helping cities around the world become more resilient against the emerging challenges of the 21st century.²



Notes:

¹ "Department of Commerce." Commerce Agencies Participate in Hurricane Sandy Rebuilding Task Force. N.p., n.d. Web. 16 Sept. 2014. <<http://www.commerce.gov/blog/2013/08/20/commerce-agencies-participate-hurricane-sandy-rebuilding-task-force>>.

² "The Rockefeller Foundation." The Rockefeller Foundation. N.p., n.d. Web. 2 Oct. 2014. <<http://www.rockefellerfoundation.org/>>.

Existing Sea Level of Boston



Expected Sea Level in 2100

Predicting 3 to 6 feet of sea level rise by 2100. Map shows 5 feet of sea level rise.



Sea Level Rise

According to the United States Environmental Protection Agency, the rate of change of the global average sea level has begun to accelerate. From 1880 to 2012 sea level increased at an average rate of .06 inches per year. Since 1993, the average sea level has risen almost twice as fast as the previous trend at a rate of .11 to .12 inches per year. Climate scientists are currently predicting that sea levels could rise by one and a half to four feet by the end of the century.¹

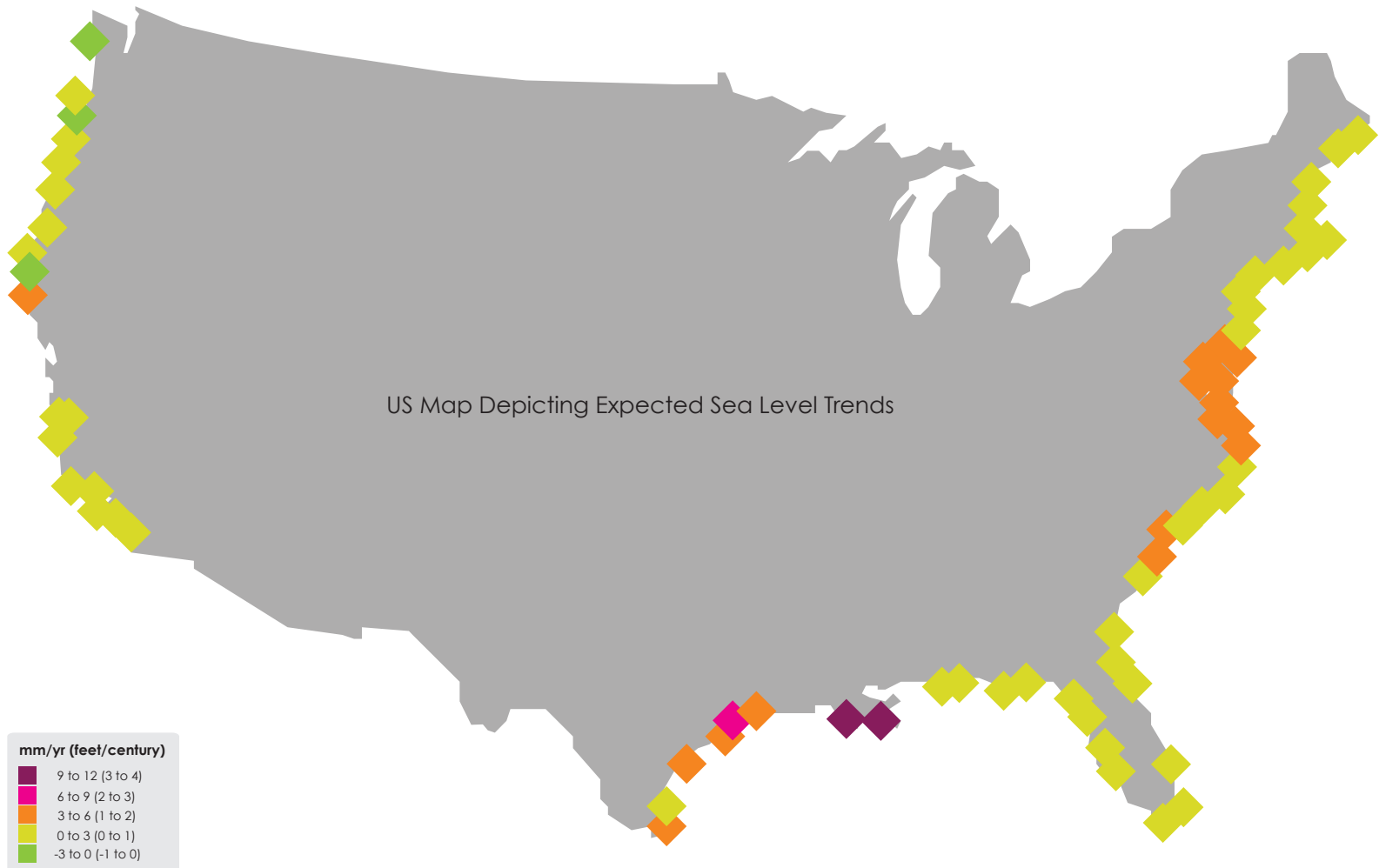
Rising sea level and storm surge have tremendous effects on waterfront regions. Coastal infrastructure becomes more susceptible to damage, flooding and erosion become more common, and saltwater flow into estuaries and groundwater aquifers increases. While sea level rise can be estimated after years of research and trend studies, the issue of storm surge is less predictable. The danger of storm surge, however, is one that will continue to increase with the rising sea level.²

Hurricane Katrina and Hurricane Sandy have demonstrated to the public that a rising sea level is a serious threat to waterfront cities, and one that should be actively addressed. As cities all over the world are being affected by rising sea levels, storms, and the corresponding damage, it is clear that modern waterfronts and the surrounding urban settings need to be designed to be resilient. The storms have put pressure on coastal regions, which encourages a collaboration between fields of study to effect a transformation of these urban waterfronts.

Waterfronts can be used as an energy source, a means for urban transportation, and a prime resource for scientific research. Innovative design measures can enhance the urbanism of waterfronts, providing a safer, more inviting, more resilient environment, as well as a more ecologically sound and energy efficient city. Embracing these future concerns that many vulnerable coastal cities face allows for a design opportunity to assist in the development of a resilient waterfront that collaborates with the ecological dynamics of the site.

Notes:

1-4 United States Environmental Protection Agency. "Sea Level." EPA. Environmental Protection Agency, n.d. Web. 8 Sept. 2014. <<http://www.epa.gov/climatechange/science/indicators/oceans/sea-level.html>>.



Absolute Sea Level Change: refers to the height of the ocean surface above the center of the earth, without regard to whether nearby land is rising or falling³

Relative Sea Level Change: how the height of the ocean rises or falls relative to the land at a particular location⁴

What causes sea level rise?

Rising Temperature

Sea level change is most commonly attributed to the rise of Earth's temperature. Rising temperature are causing the slight expansion of water as it warms throughout the depths of the oceans,

Melting Glaciers

The rise in Earth's temperature is causing the melting of glaciers and the corresponding increase in volume of water in the oceans.

Geological Uplift and Subsiding

Sediment accumulations and geological uplift can cause land to rise, while erosion, natural subsidence, and sediment compaction can cause land to sink.

Continental Uplift and Subsiding

In addition to sections of land rising and falling, the Earth's continents continue to do this as well relative to their surrounding oceans.

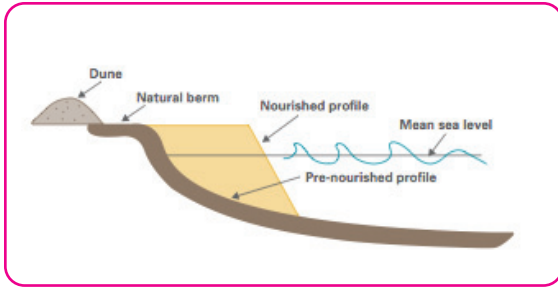
Ocean Currents

Natural changes in ocean currents are also attributed to sea level change.

Notes:

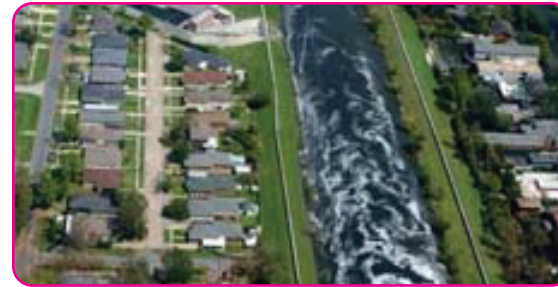
¹ United States Environmental Protection Agency. "Sea Level." EPA. Environmental Protection Agency, n.d. Web. 8 Sept. 2014. <<http://www.epa.gov/climatechange/science/indicators/oceans/sea-level.html>>.

Hard Infrastructure Systems



Beach Fill

An engineered method of replacing sand on a beach where it has previously eroded.¹



Levees

Earthen embankments or concrete floodwalls designed to contain, control or divert the flow of water.⁵



Groins

Hard structures perpendicular to the shore that influence the movement of sediment along the shore by waves and currents.²



Sea Walls

Hard structures parallel to the shore that help stop waves from effecting the shore or beachfront dwellings.³



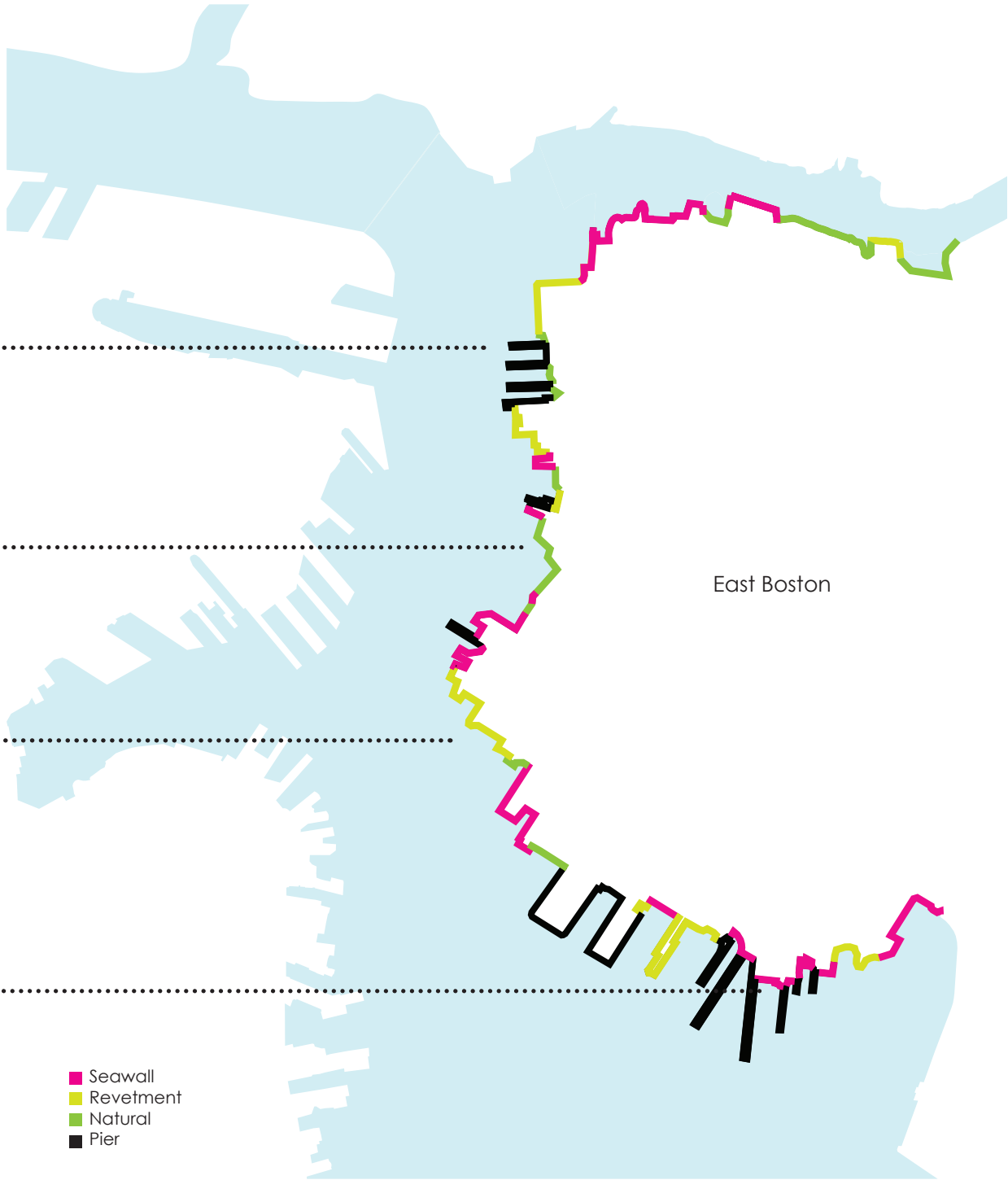
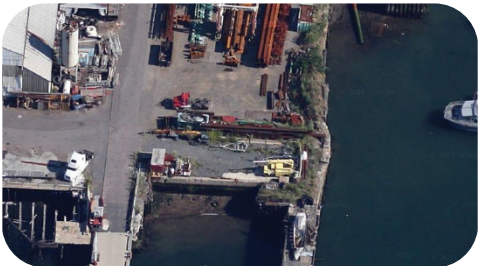
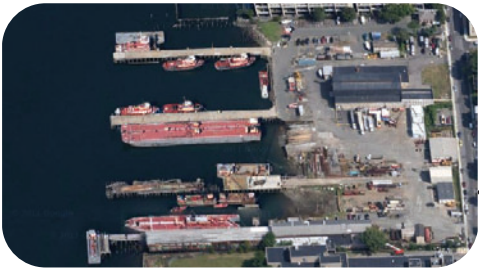
Revetments

Stone or concrete facings used to sustain an embankment.⁴

Notes:

¹⁻⁵ "How Beach Nourishment Projects Work." US Army Corps of Engineers. N.p., n.d. Web. 19 Sept. 2014. <[http://www.nan.usace.army.mil/Portals/37/docs/civilworks/Sandyfiles/How BeachNourishmentWorks.pdf](http://www.nan.usace.army.mil/Portals/37/docs/civilworks/Sandyfiles/How%20Beach%20Nourishment%20Works.pdf)>.

Describing the East Boston Edge





Interboro Team Proposal for Rebuild by Design

This portion of the design for Nassau County's South Shore proposed protective infrastructure that doubles as a landscape amenity and a storm water landscape where storm water is stored, cleaned, and replenished.¹



OMA Team Proposal for Rebuild by Design

This strategy for Hoboken proposed a comprehensive urban strategy of resist, delay, store, and discharge in order to manage flash flood and storm surge.²



SCAPE/ Landscape Architecture Team Proposal for Rebuild by Design

The Living Breakwaters Project proposes a breakwater system with micropockets of habitat to host finfish, shellfish, and lobsters on Staten Island's South Shore. A series of programmed water hubs work to connect people to the water.³

Notes:

¹⁻³ "Working Together to Build a More Resilient Region." Rebuild by Design Working Together to Build a More Resilient Region Comments. N.p., n.d. Web. 16 Sept. 2014. <<http://www.rebuildbydesign.org/>>.

Characteristics of a Resilient System



Integrated

The ability of individuals, groups, and organizations to bring together thoughts and elements into cohesive actions and solutions. Integration involves collaborative development of solutions through the sharing of information and ideas across entities.



Diverse

The ability and capacity of a system to operate successfully under a variety of situations beyond what is regularly needed. Diversity should not rely solely on one element for a given purpose, but should allow for redundancy, alternatives, and backups. In the case of disruption, a diverse system has the ability to switch over to an alternative mode of functioning. Diversity also allows for a variety of capabilities, technical elements, and information sources for different people, groups, or places.



Adaptive

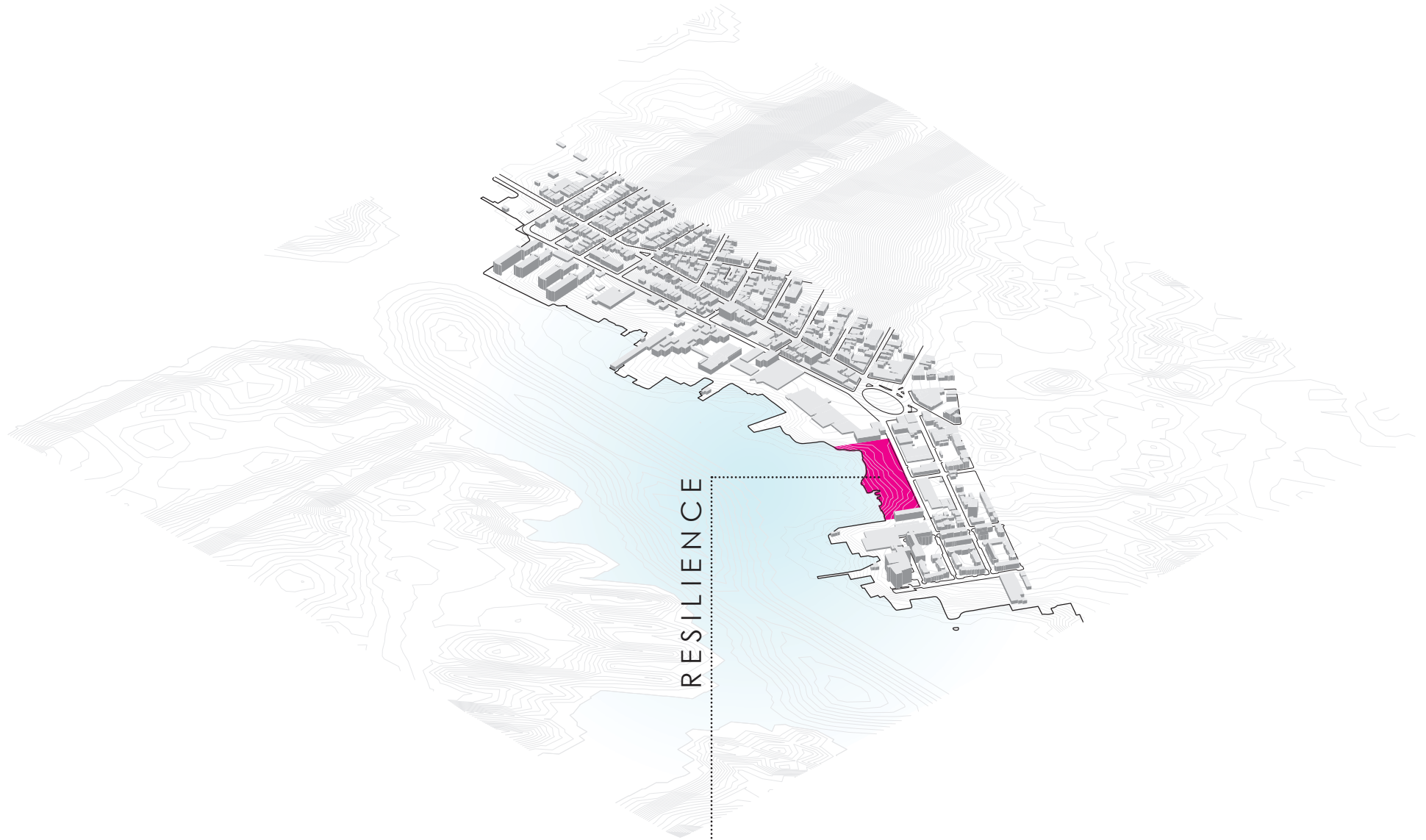
The ability to adjust to changing circumstances during a disruption. Adaptability is the flexibility to develop new plans and actions or adjusting roles or behaviors in order to better withstand and recover from a disruption.

Notes:

"The Rockefeller Foundation." The Rockefeller Foundation. N.p., n.d. Web. 2 Oct. 2014. <<http://www.rockefellerfoundation.org/>>.

Resilient Waterfronts

Absorb Disturbances + Facilitate Change + Maintain Identity



RESILIENCE

Architecture

Landscape

LANDFORM BUILDING

SOFT INFRASTRUCTURE

S I T E



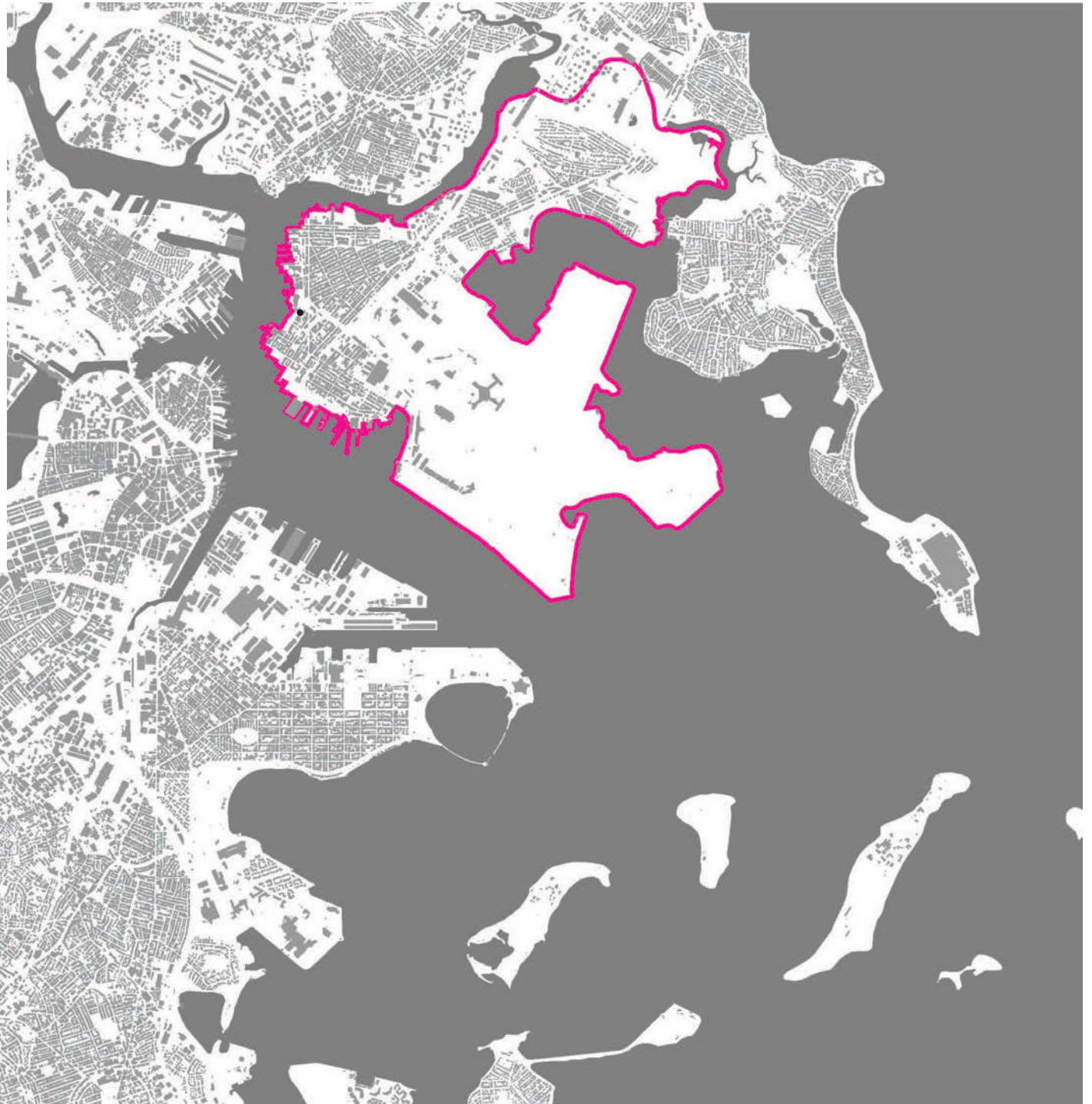
East Boston

East Boston is a neighborhood located to the northeast of Boston surrounded by the Boston Harbor and the Chelsea River to the north. The neighborhood is known today for its residential neighborhoods with a 2010 population of 40,508, hosting a large population of immigrants, longtime residents, and young professionals.¹ In recent years, the East Boston neighborhood has been the site for many initiatives, some underway and some in planning, to transform the old and dilapidated coastline into a more resilient and developed urban waterfront.²

Notes:

1 <http://www.cityofboston.gov/neighborhoods/eastboston.asp>

2 <http://www.bostonredevelopmentauthority.org/neighborhoods/east-boston/at-a-glance>



Sea Level Rise in East Boston



Existing Sea Level

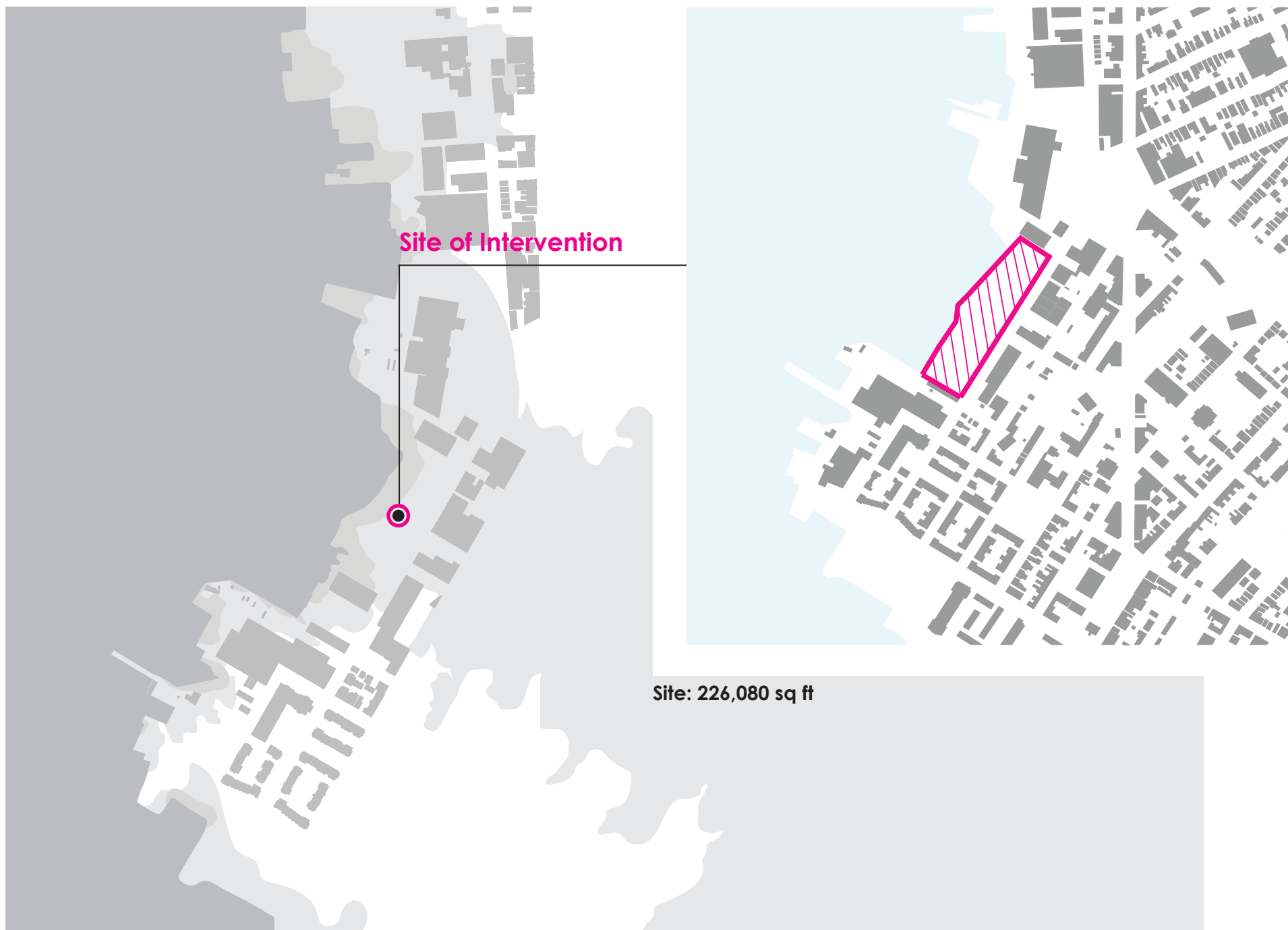


2.5 Feet of Sea Level Rise



5 Feet of Sea Level Rise





Site: 226,080 sq ft

East Coast Estuary Cities

An estuary is defined as a partially enclosed body of water along a coast where freshwater from streams and rivers meets saltwater from the ocean.¹ Estuaries are particularly sensitive to sea level rise and climate change. Erosion from rising sea levels, precipitation levels, and changes in storm frequency and intensity directly effect estuaries.² Many estuary systems adjust to rising sea levels by expanding inland laterally or vertically, inevitably effecting coastal environments and populations with the accelerating sea level rise. Beaches are being eroded, low-lying lands and wetlands are being submerged, and coastal infrastructure and development is increasing in vulnerability along estuary cities. Rising sea level is also rapidly increasing the salinity of estuaries and impacting freshwater sources.³ Most of the cities that are highly vulnerable to rising sea levels are considered estuary cities. The table below shows the high relative sea level rise rates of estuary cities as compared to the global average of 1.7 millimeters per year.⁴

Station	mm/yr	inches/yr
Portland , ME	1.91 ± 0.09	0.0764 ± 0.0035
Boston, MA	2.65 ± 0.10	0.1060 ± 0.0039
Atlantic City, NJ	3.98 ± 0.11	0.1592 ± 0.0043
Baltimore, MD	3.12 ± 0.16	0.1248 ± 0.0063
Annapolis, MD	3.53 ± 0.13	0.1412 ± 0.0051
Washington, DC	3.13 ± 0.21	0.1252 ± 0.0083
Philadelphia, PA	2.75 ± 0.12	0.1100 ± 0.0047
Portsmouth, VA	3.76 ± 0.23	0.1504 ± 0.0091
Charleston, SC	3.28 ± 0.14	0.1312 ± 0.0055
Miami, FL	2.39 ± 0.22	0.0956 ± 0.0087



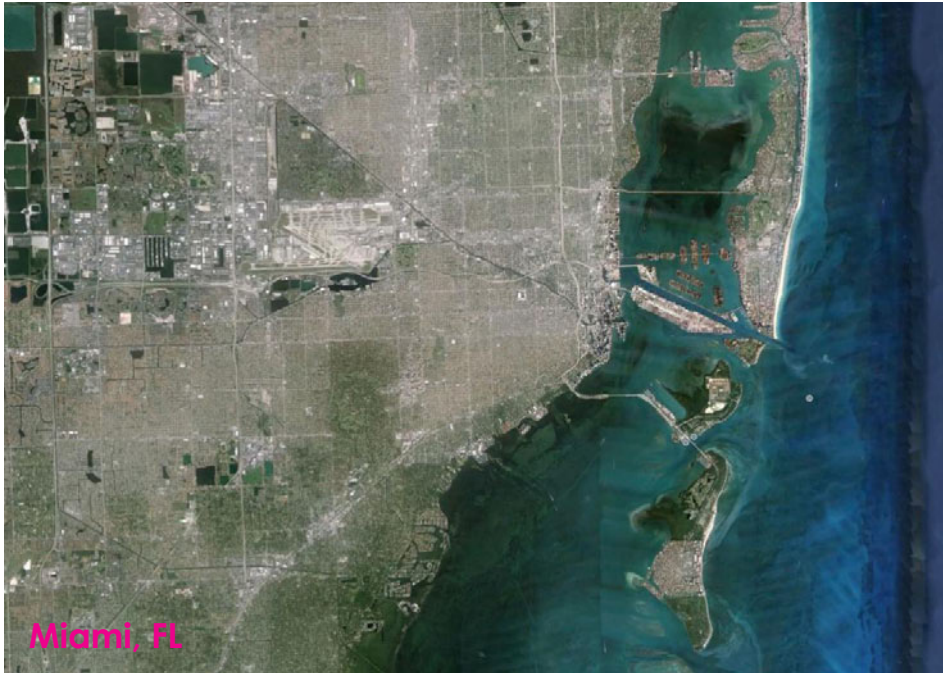
Notes:

¹ "Estuaries and Coastal Watersheds." Home. N.p., n.d. Web. 6 Oct. 2014. <<http://water.epa.gov/type/oceb/nep/index.cfm>>.

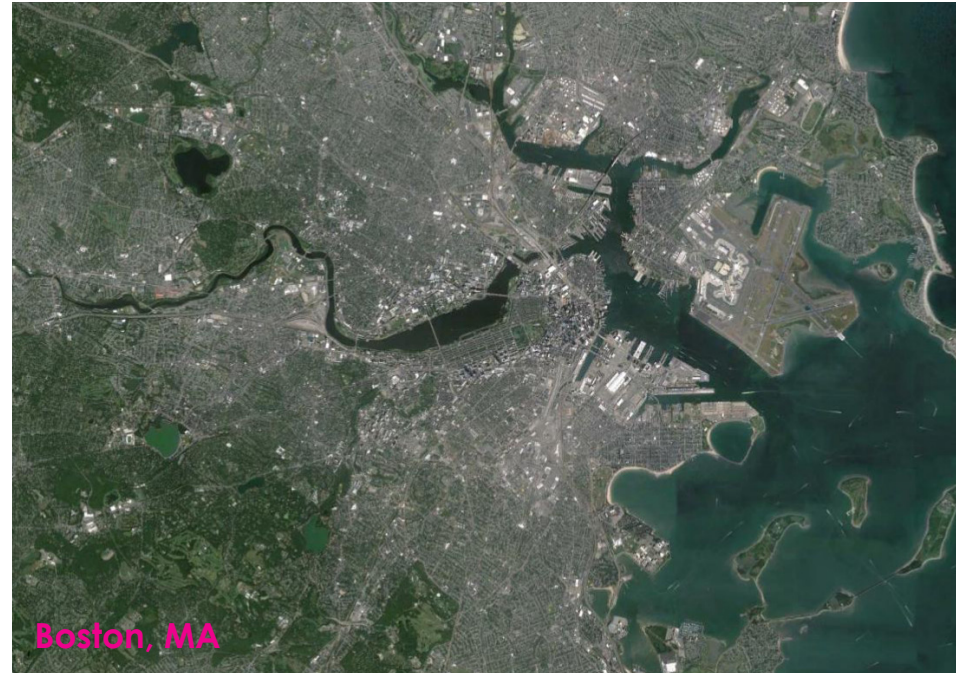
² "Coastal Areas Impacts & Adaptation." EPA. Environmental Protection Agency, n.d. Web. 5 Oct. 2014. <<http://www.epa.gov/climatechange/impacts-adaptation/coasts.html>>.

³ "Coastal Sensitivity to Sea Level Rise: A Focus on the Mid Atlantic Region." U.S. Climate Change Science Program (2009). Print.

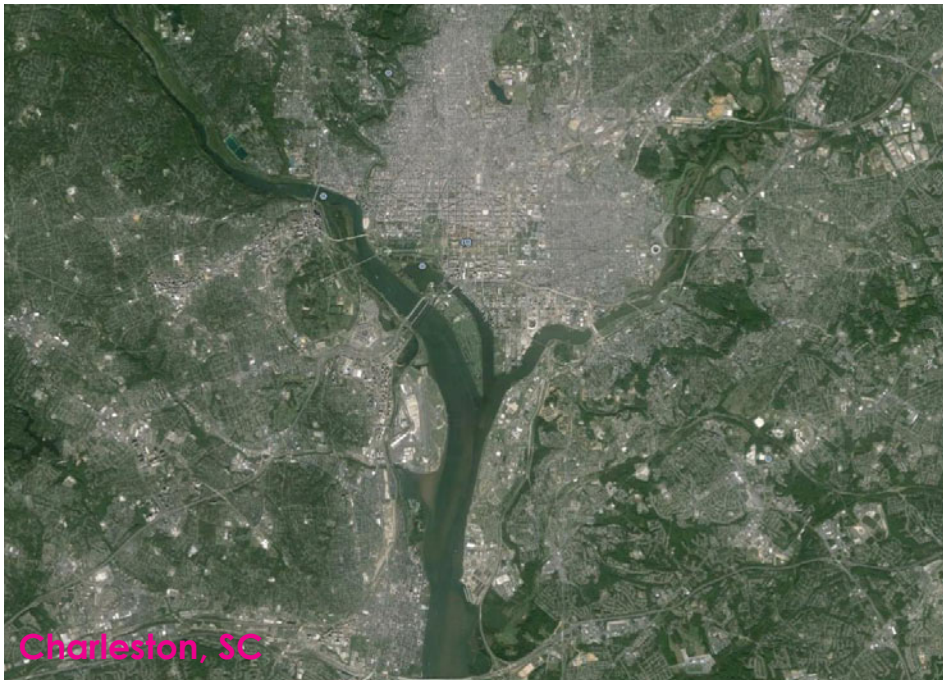
⁴ "The Impact of Climate Change on the Mid-Atlantic Region." EPA. Environmental Protection Agency, n.d. Web. 7 Oct. 2014. <<http://www.epa.gov/reg3artd/globclimate/ccimpact.html>>.



Miami, FL



Boston, MA



Charleston, SC



Washington, D.C.

Boston as an Urban Estuary

Population 2010: 617,594

Estimated Population 2014: 645,966

Area of Land: 48.43 Sq Mi of Land

Total Area: 89.63 Sq Miles

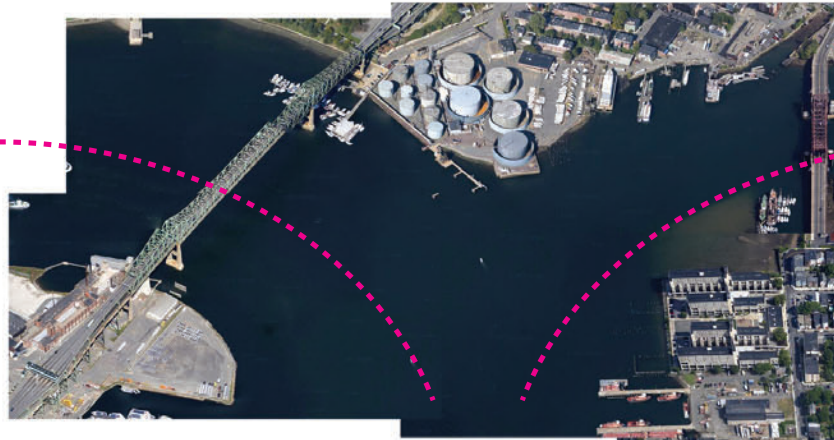
The city of Boston is located on the large estuarine harbor which is fed by the Mystic and Chelsea Rivers and connected to the Atlantic Ocean through the Boston Harbor. Boston and the harbor are sheltered geographically by Cape Cod and the Harbor Islands. The estuary system of Boston covers approximately 41.2 square miles of surface area. The Boston Harbor is surrounded by the dense urban development of downtown Boston, Chelsea, South Boston, and Back Bay, with the residential neighborhood of East Boston. With an estimated population of 645,966 in 2014, Boston is one of the largest estuary cities in the United States.



Notes:

City of Boston. http://www.cityofboston.gov/images_documents/Boston_brochure_tcm3-19117.pdf

Mystic River



Chelsea River



Boston Harbor

What makes a city vulnerable?

Transit Systems

- Evacuation
- Supplies
- Resources

Topography and Bathymetry

Ecology

- Existing Wetlands
- Threatened Wetlands

Existing Infrastructure

- Where does it/does it not exist?
- Where should it be supplemented?

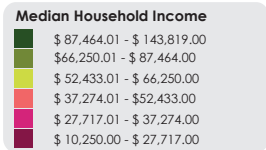
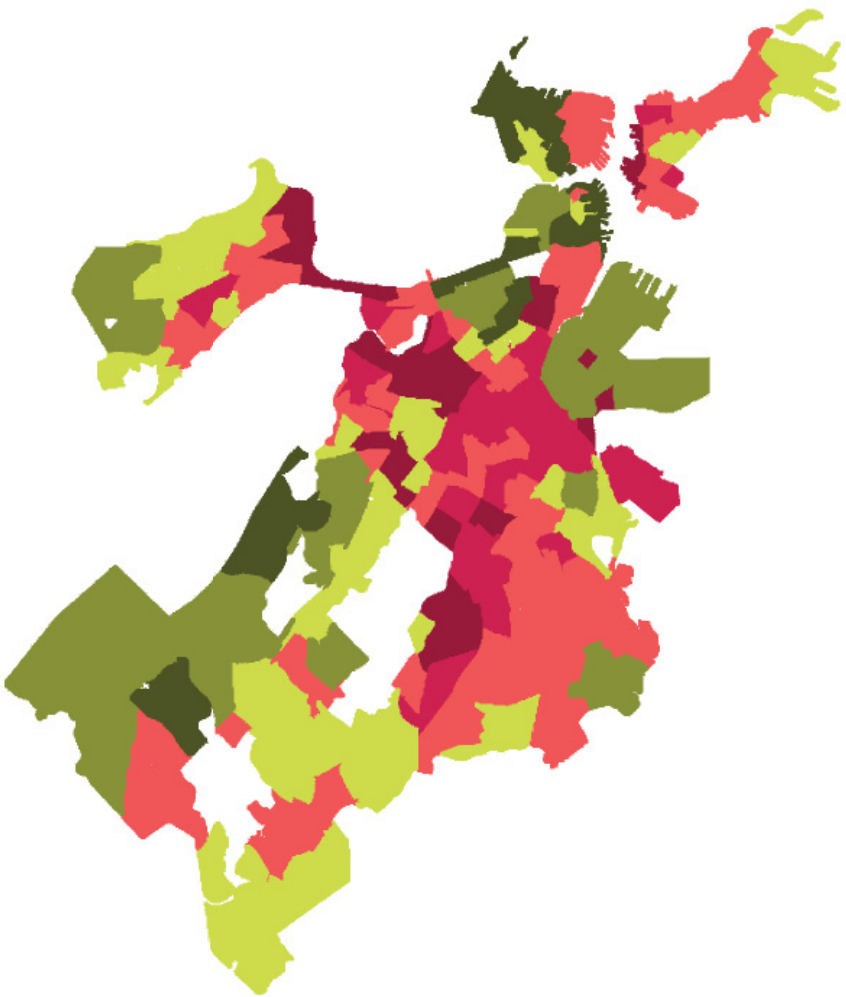
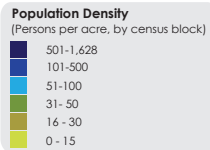
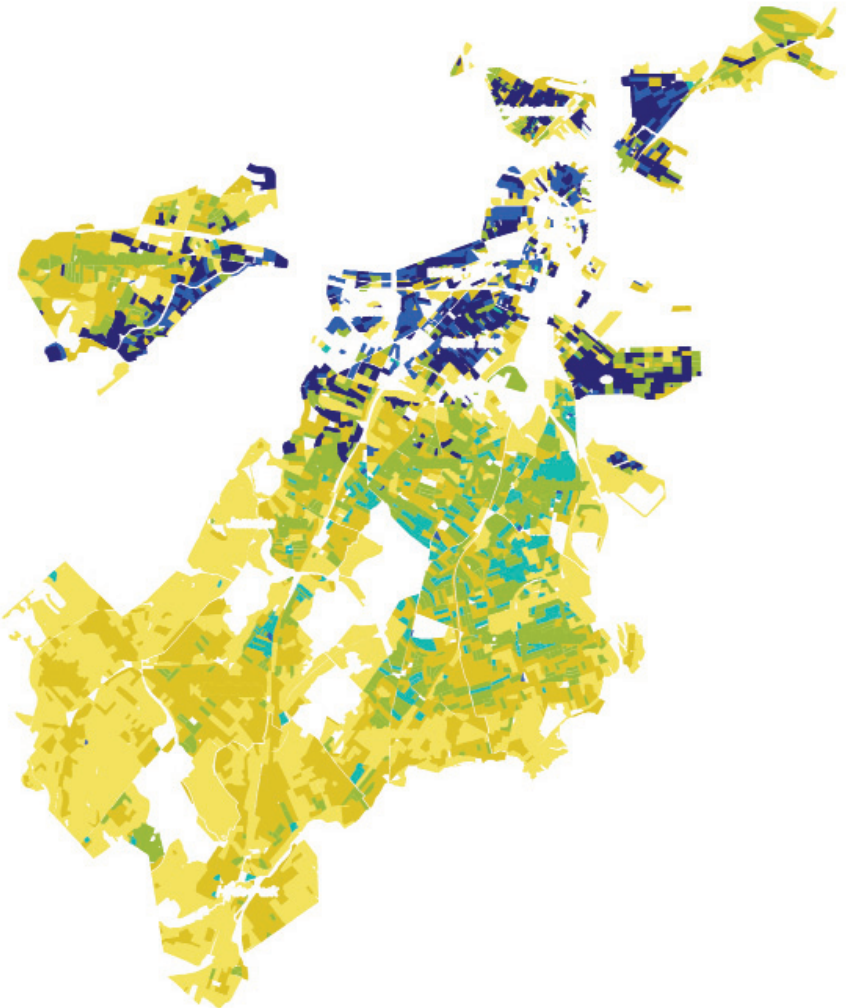
Residential

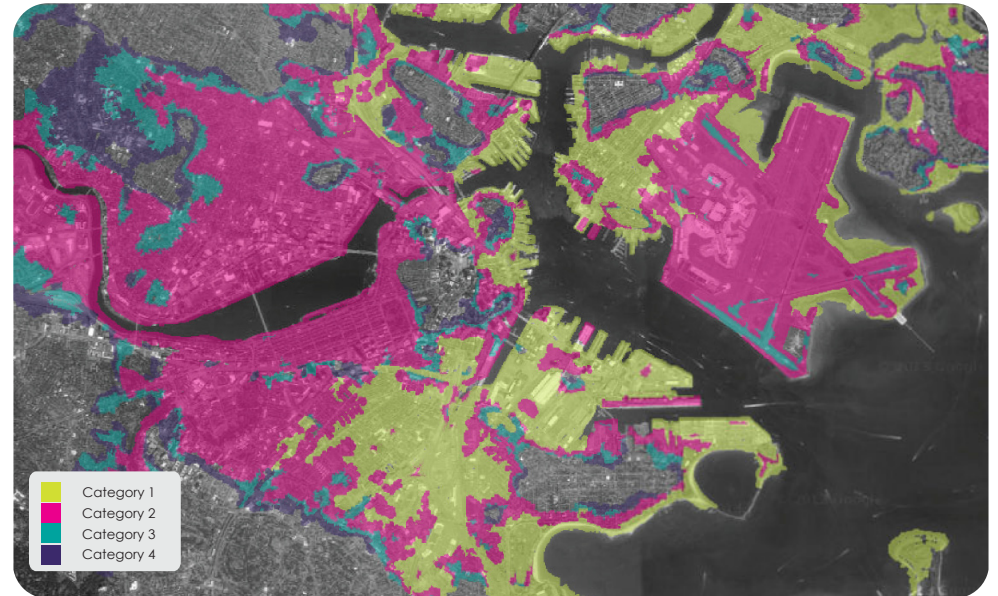
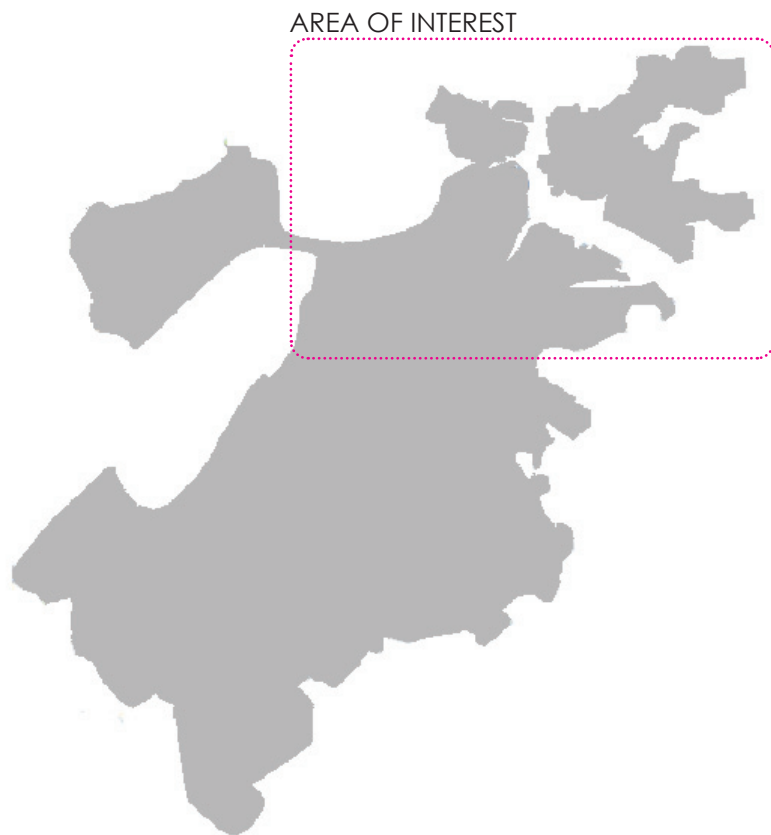
- High Density
- Demographics

Land Use

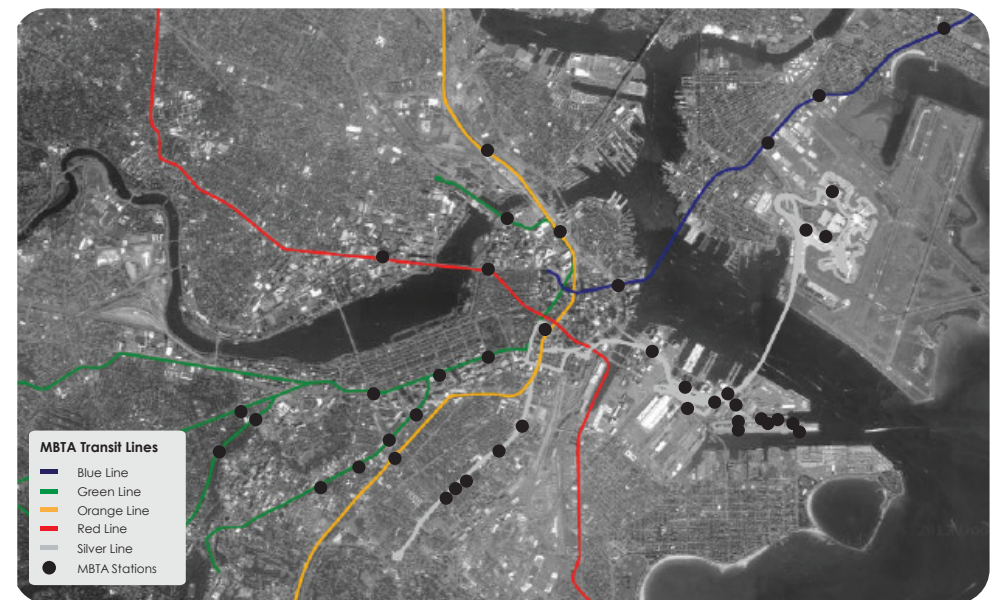
Power and Energy Sources

City Wide Demographics





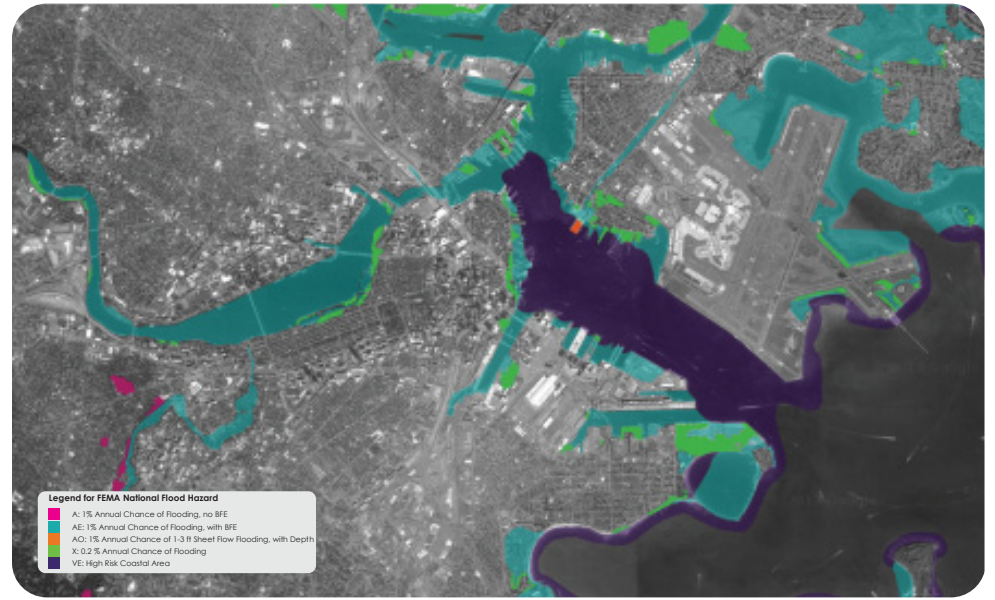
Hurricane Inundation Zones



MBTA Transit Lines



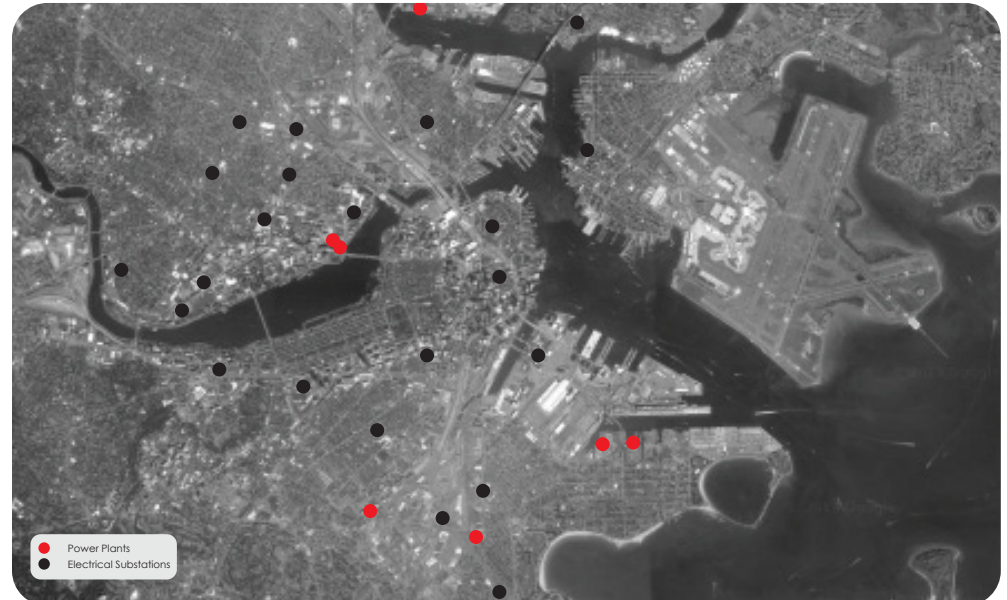
Land Use



FEMA Flood Zones

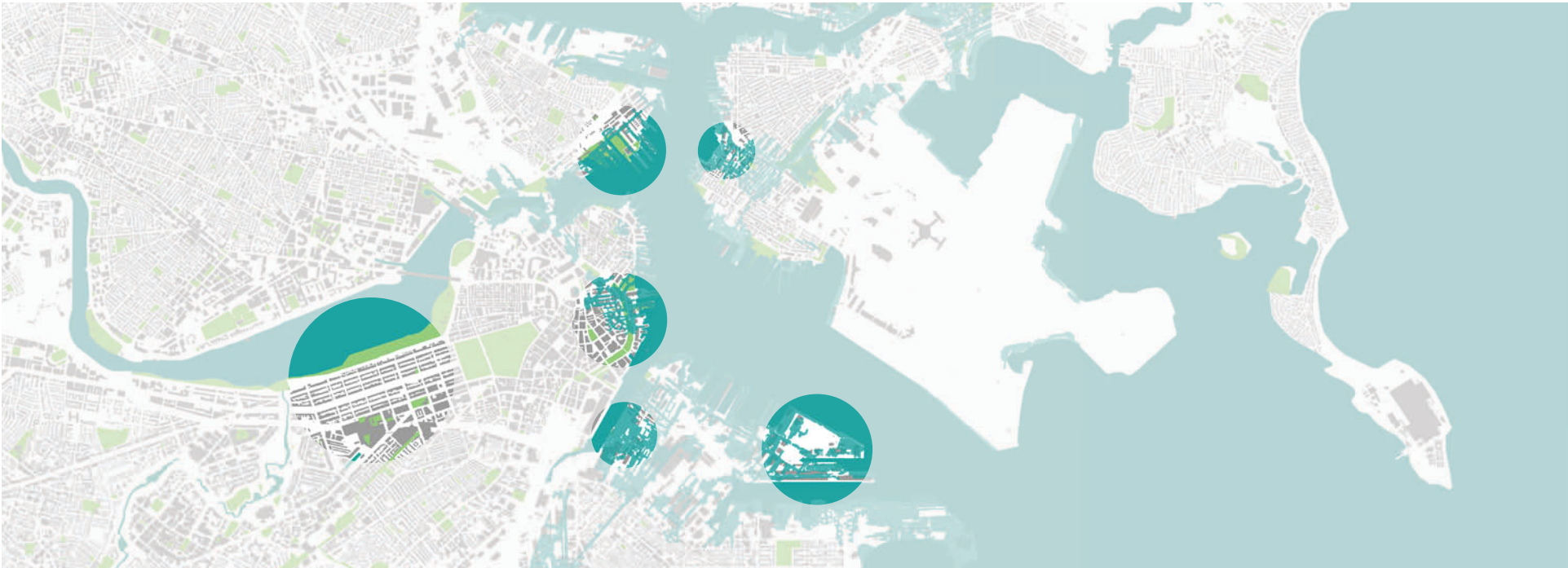


Wetlands



Power Supply

Vulnerable Sites of Interest



Back Bay



Charlestown Navy Yard



East Boston

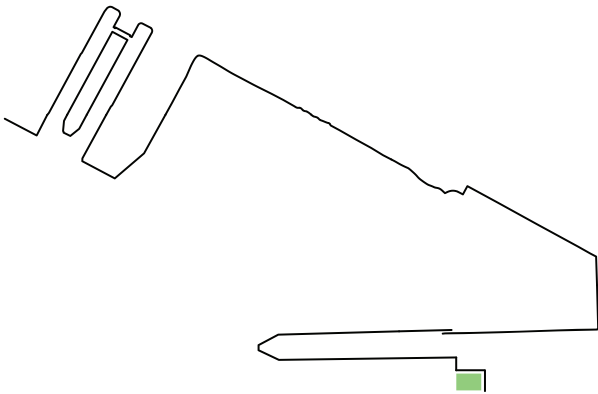


Fort Point Channel

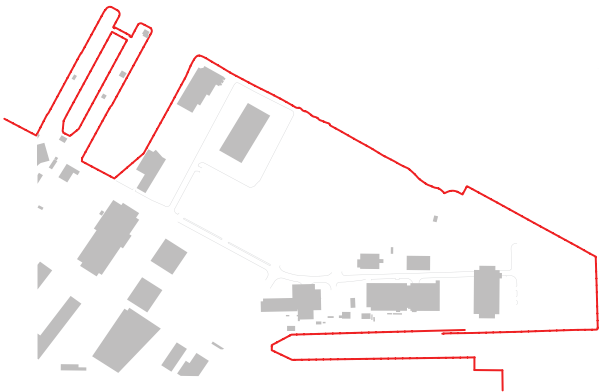


South Boston Seaport District

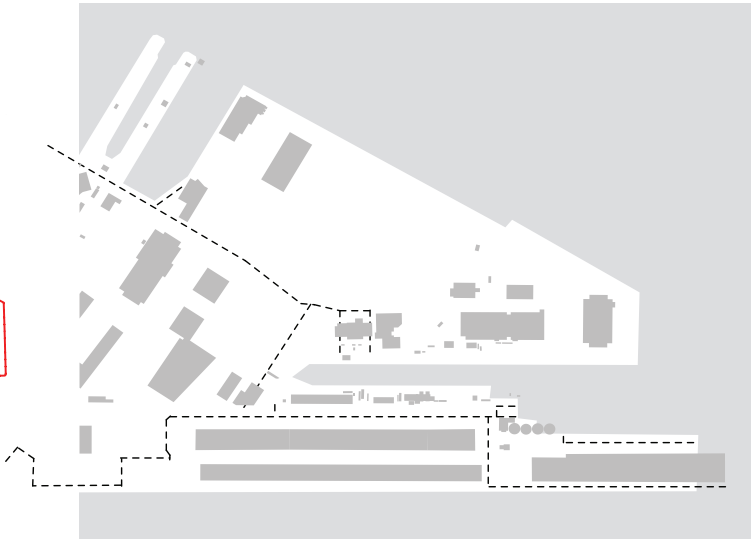
South Boston Seaport District



Green Space

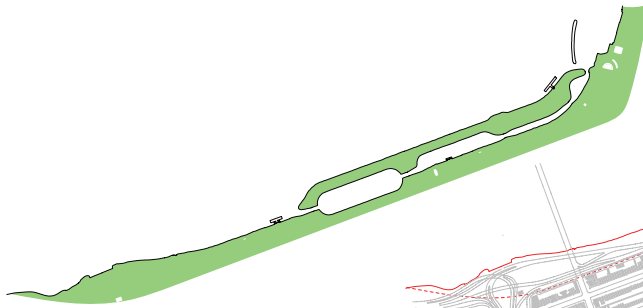


Edge Condition

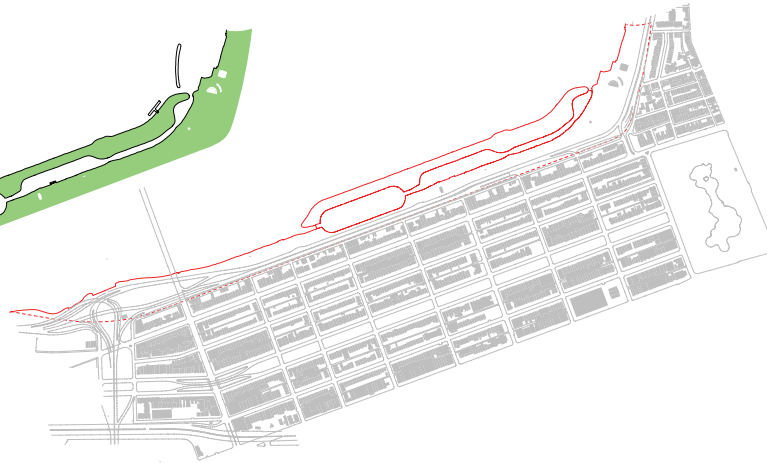


Waterfront Development

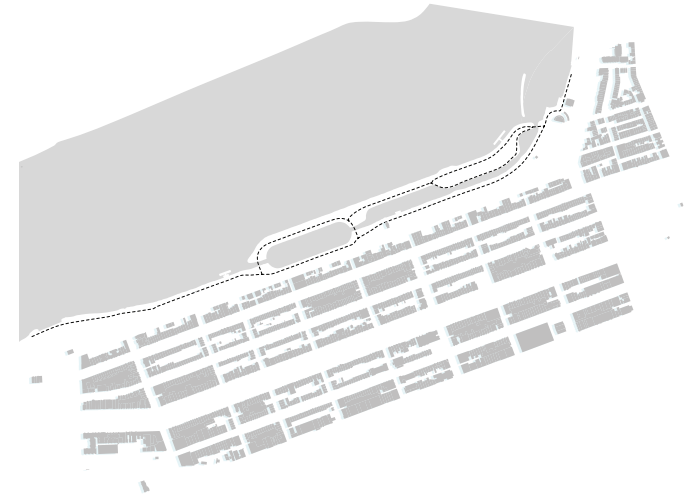
Back Bay



Green Space

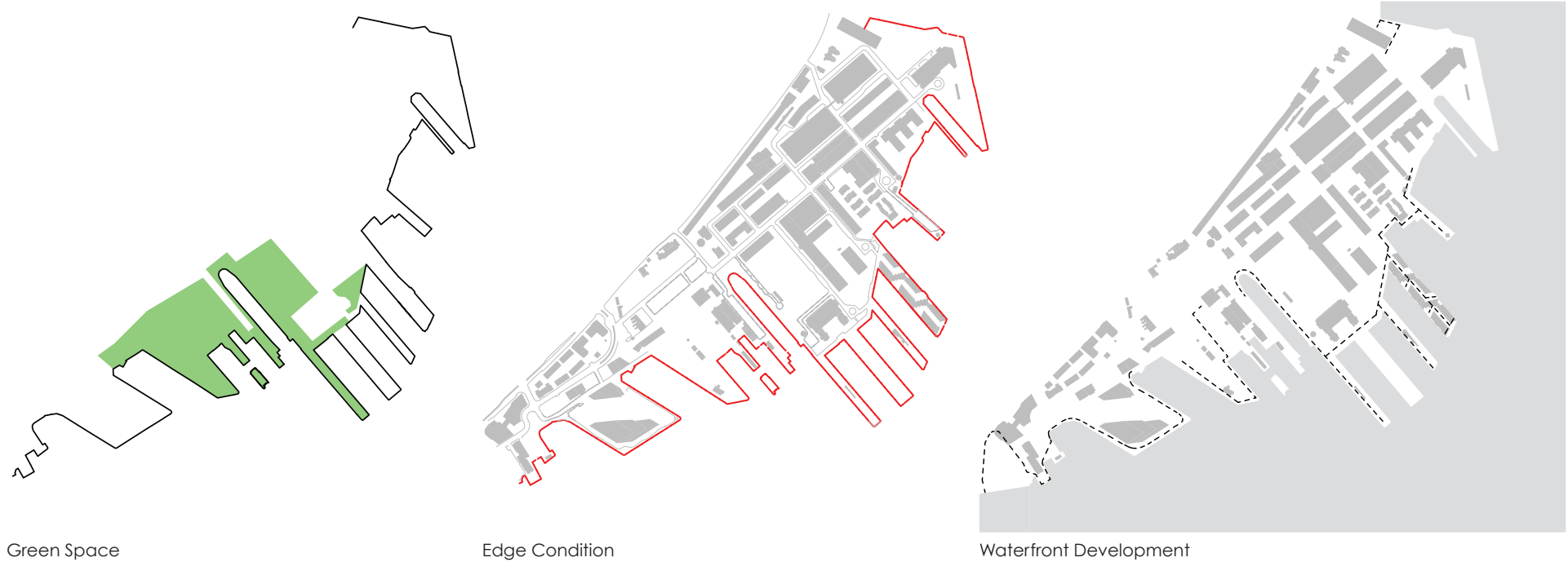


Edge Condition

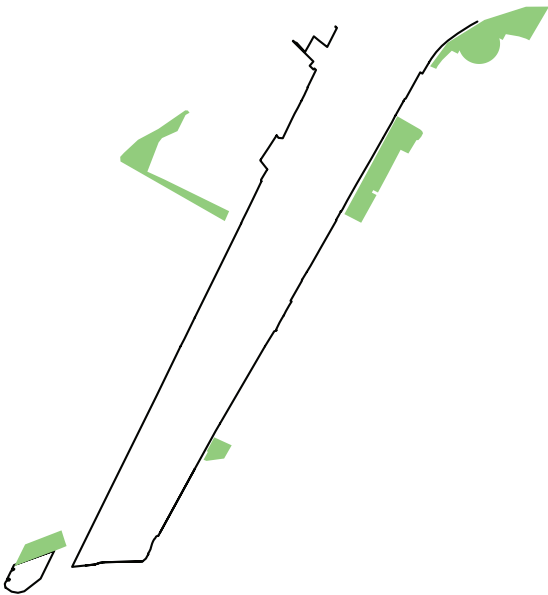


Waterfront Development

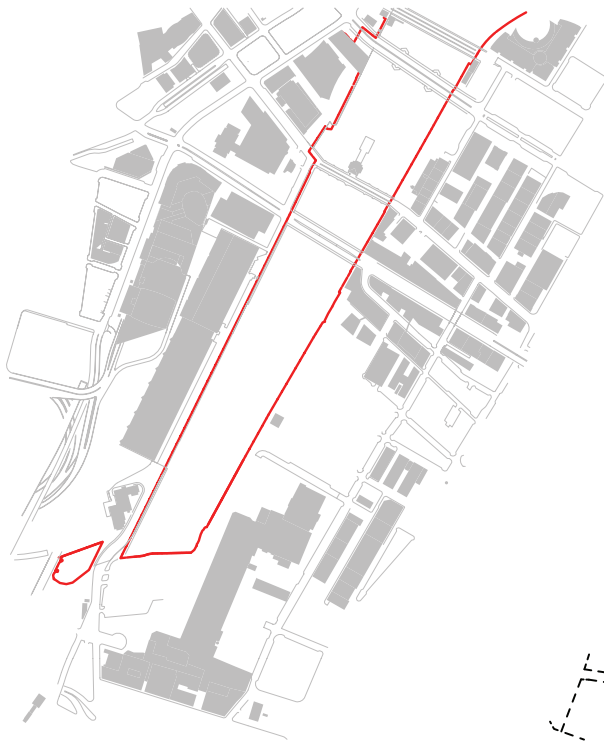
Charlestown Navy Yard



Fort Point Channel



Green Space

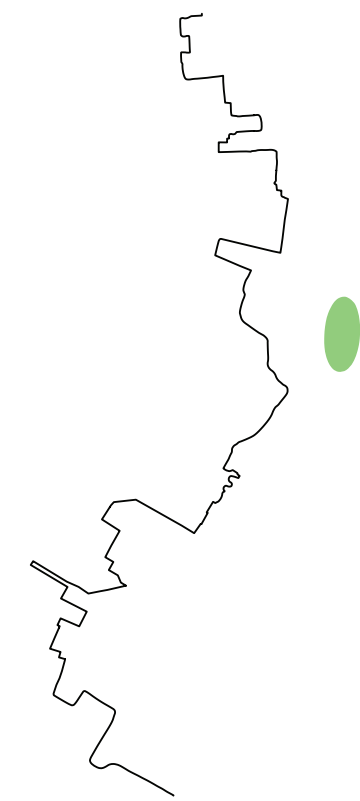


Edge Condition



Waterfront Development

East Boston Site of Intervention



Green Space



Edge Condition



Waterfront Development

History of East Boston

The neighborhood of East Boston was originally a group of five islands connected by landfill to create the neighborhood as it is today. The largest original island served as one of the main sources of wood for early colonists. East Boston then became a center for Clippership building, shipping and trade. The neighborhood changed from a residential suburban area for Boston's wealthy to a neighborhood attracting working class immigrants. The large immigrant population worked in the ports, ship yards and other marine industries. When the ship building demand declined, the neighborhoods trade and port activity increased.

After East Boston's first ship launched in 1839, the neighborhood began to prosper as a shipbuilding center and Boston became one of the leading ports in the world. The waterfront could be found lined with wharves and warehouse for shipbuilding and servicing.

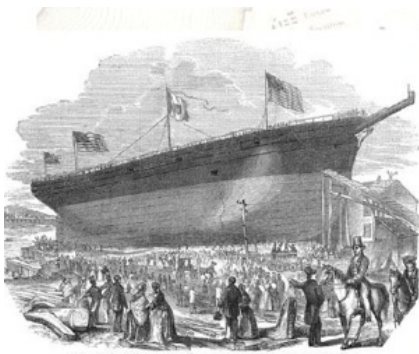
The islands were annexed in 1836 by the City of Boston. Beginning in the 1830's, the site began development for homes and business under the East Boston Company. Because of this, East Boston is one of the few neighborhoods that was designed with a formal urban plan.

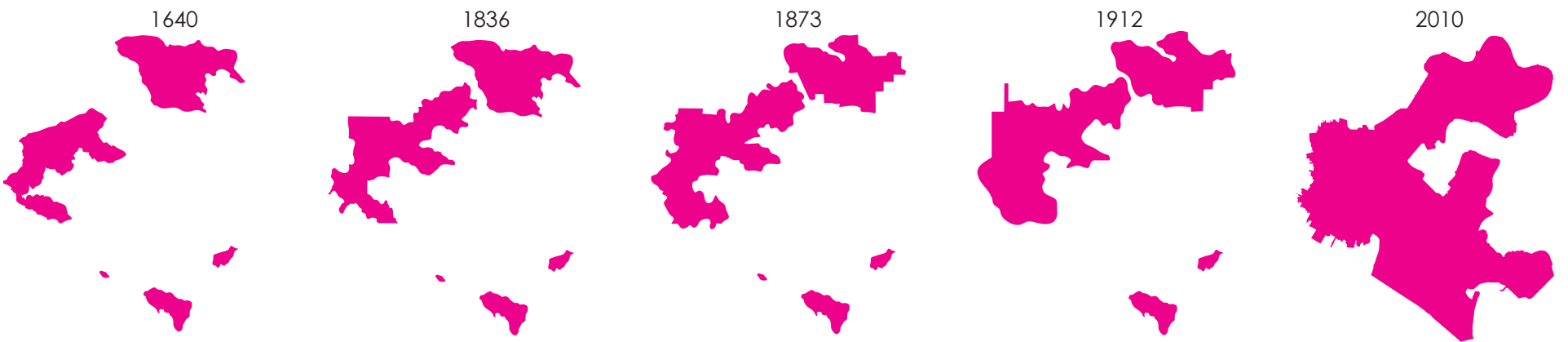
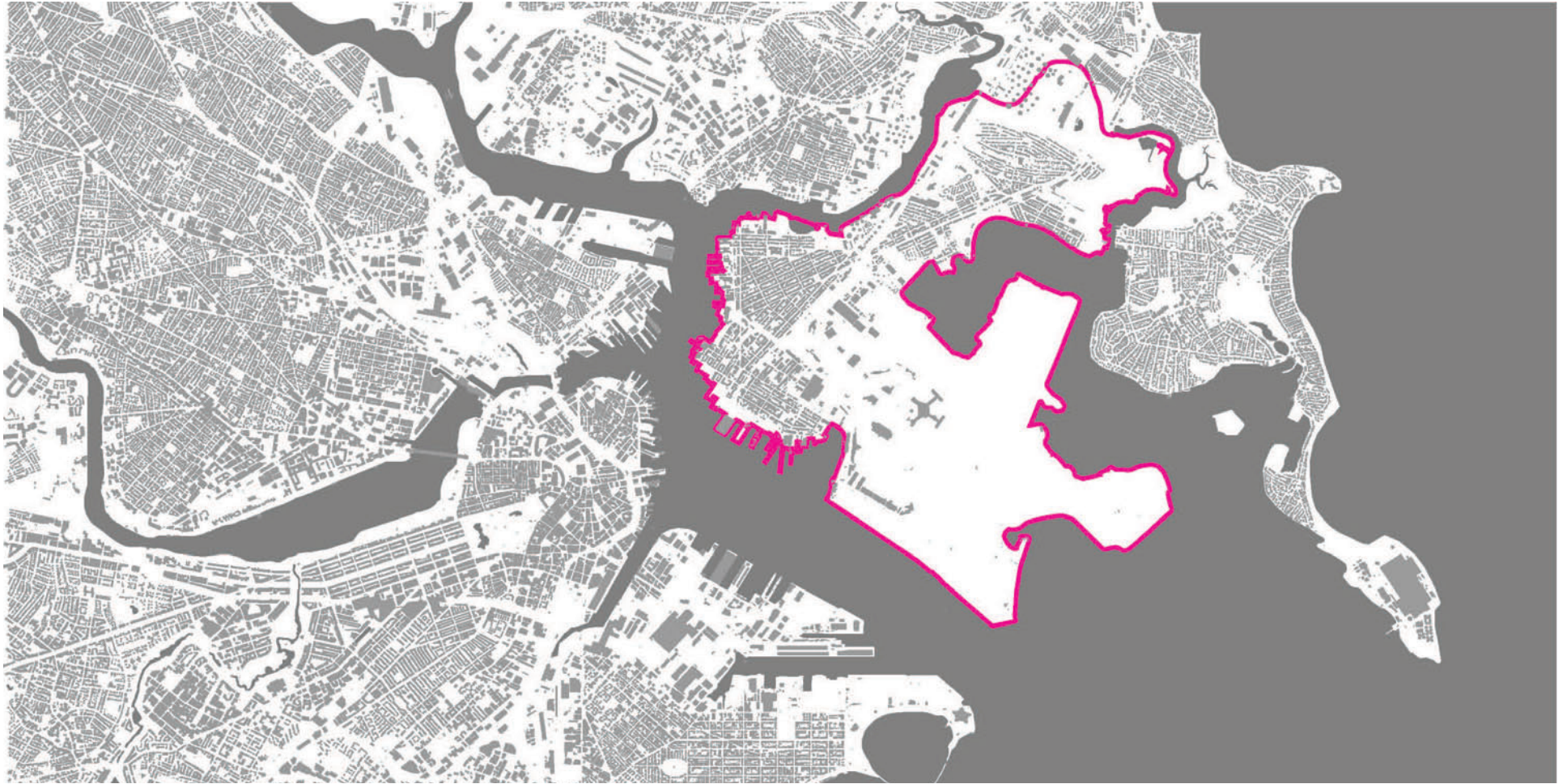
Because of East Boston's high trade and port activity, the neighborhood has always been an important transportation center. Due to its location relative to downtown Boston, a public steam ferry service was developed and proved essential to the community's accessibility and success. In the 1920's, East Boston became the site for Logan International Airport, Boston's only airport.

Notes:

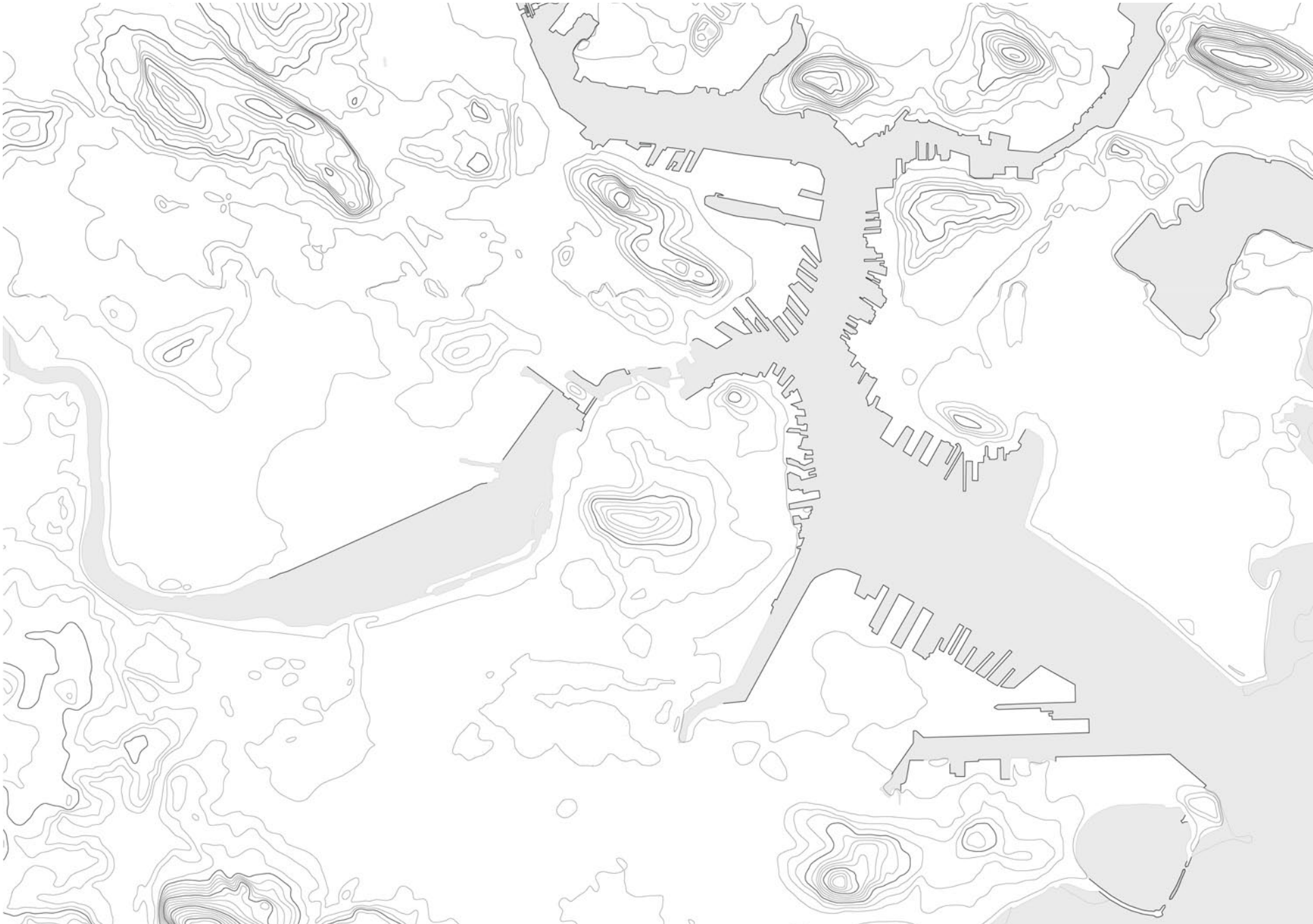
¹ <http://www.northeastern.edu/urbanstudiesminor/wp-content/uploads/East-Boston-Immigrant-History-tour.pdf>

² http://www.cityofboston.gov/images_documents/East_Boston_brochure_tcm3-19117.pdf





Topography





Combined Topography and Bathymetry of East Boston



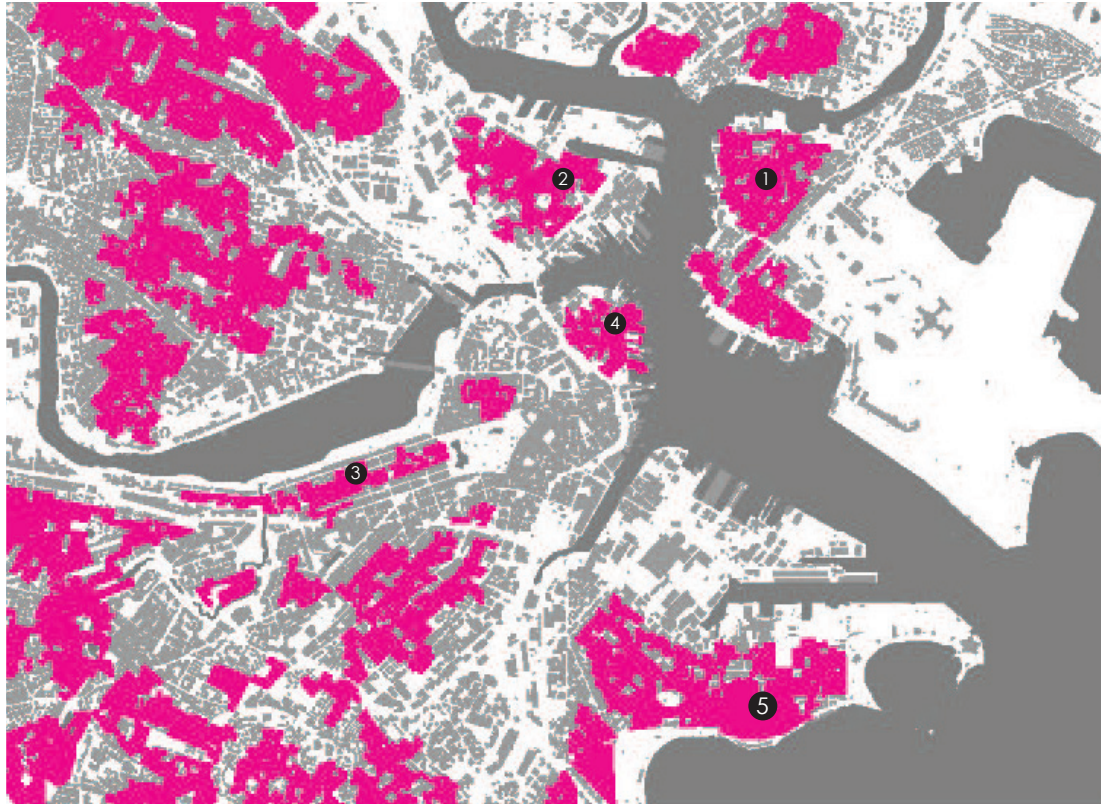
Topography and Bathymetry of East Boston with Existing Coastline

Existing Site Evaluation

The neighborhood of East Boston is one of the greater city of Boston's main residential neighborhoods. With existing site conditions and the high density of immigrants, long time residents, and young professionals, the lower-demographic population is incredibly at risk to sea level rise, with less resources to bounce back from potential disasters.

As a former shipbuilding industry site, the East Boston waterfront is lined with dilapidated wharves and piers. The waterfront has remained undeveloped in most areas, lacking both hard and soft infrastructure systems to combat the risk of sea level rise. Recent development projects have focused on the implementation of Boston's Harborwalk Development along the coastline, adding both hard infrastructure and green spaces. The specific site of interest on Border Street is currently an undeveloped waterfront with rubble from destroyed piers separated from the street by a small chain link fence. The site is low-lying and meets the waterfront directly, exposing a huge portion of the neighborhood to the risk of rising sea levels.





Boston Residential Zones

- ① East Boston
- ② Charlestown
- ③ Back Bay
- ④ Downtown
- ⑤ South Boston

Area: 4.736 square miles

Population 2010: 40,508

Population Density:

East Boston: 8,114 people per square miles

Boston: 12,906 people per square mile



Median Rent:

East Boston: \$917

Boston: \$1,118



Average Household Size:

East Boston: 2.7 people

Boston: 2.3 people

Percentage of Family Households:

East Boston: 48.4%

Boston: 38.0 %



Percentage of Foreign Born Residents:

East Boston: 49.2 %

Boston: 26.5%

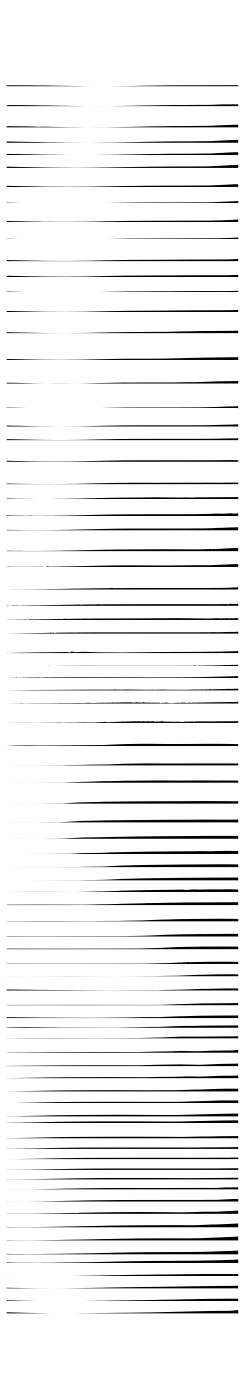
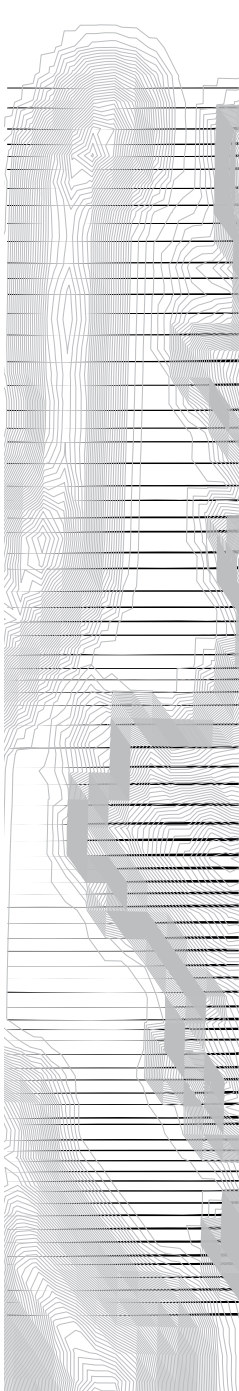
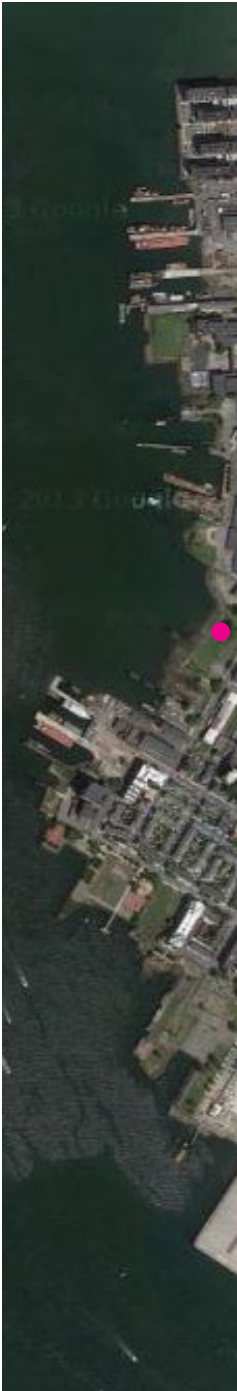


Notes:

¹ <http://www.northeastern.edu/urbanstudiesminor/wp-content/uploads/East-Boston-Immigrant-History-four.pdf>



Existing Coastline



East Boston Transportation Networks

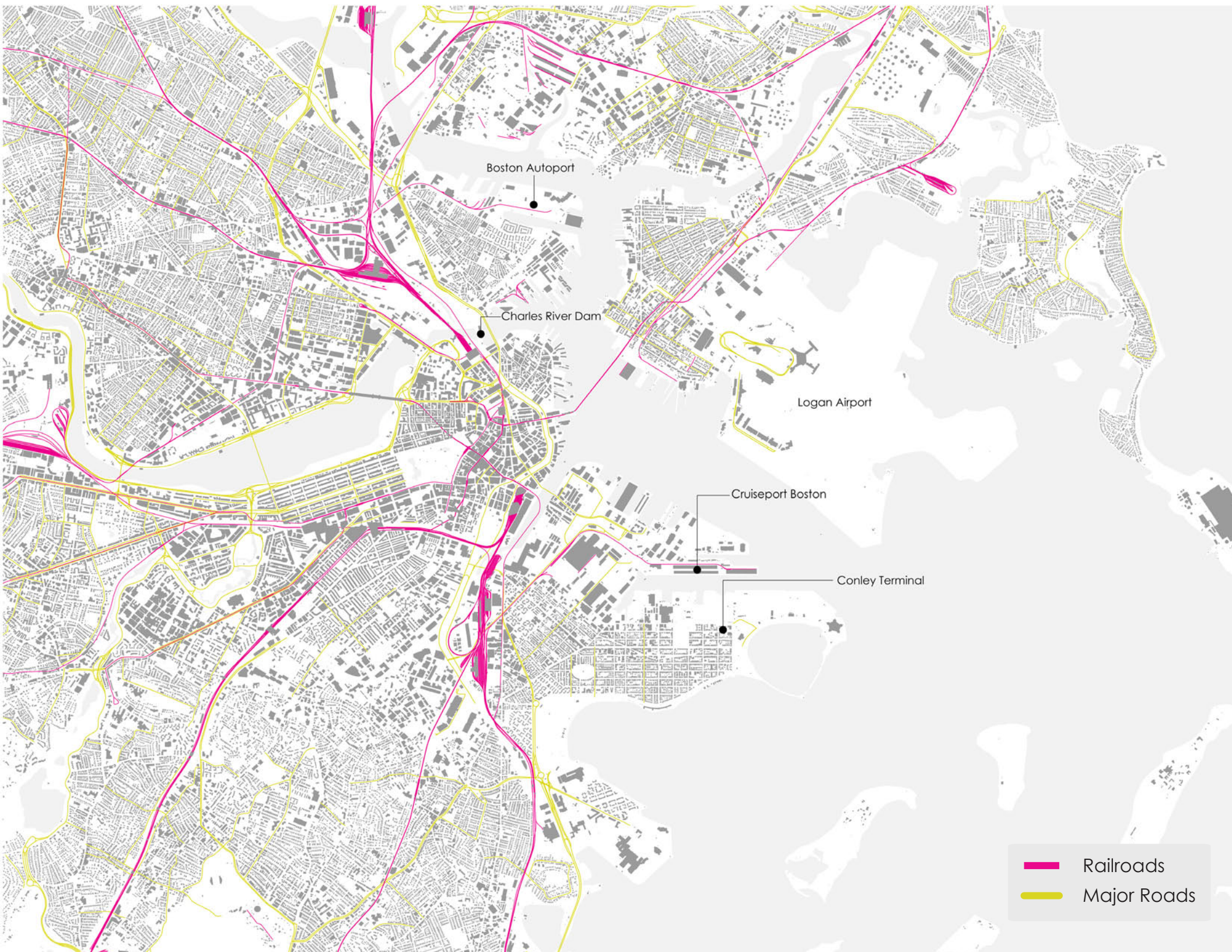
As a former site of high trade and port activity, the neighborhood of East Boston was an important transportation center. Its location across the harbor from the greater city of Boston, however, has made it only accessible through the MBTA Ferry and Transit Lines and the 1A and I-90 tunnels.



MBTA Ferry Terminals



MBTA Transit Lines



Boston Autoport

Charles River Dam

Logan Airport

Cruiseport Boston

Conley Terminal

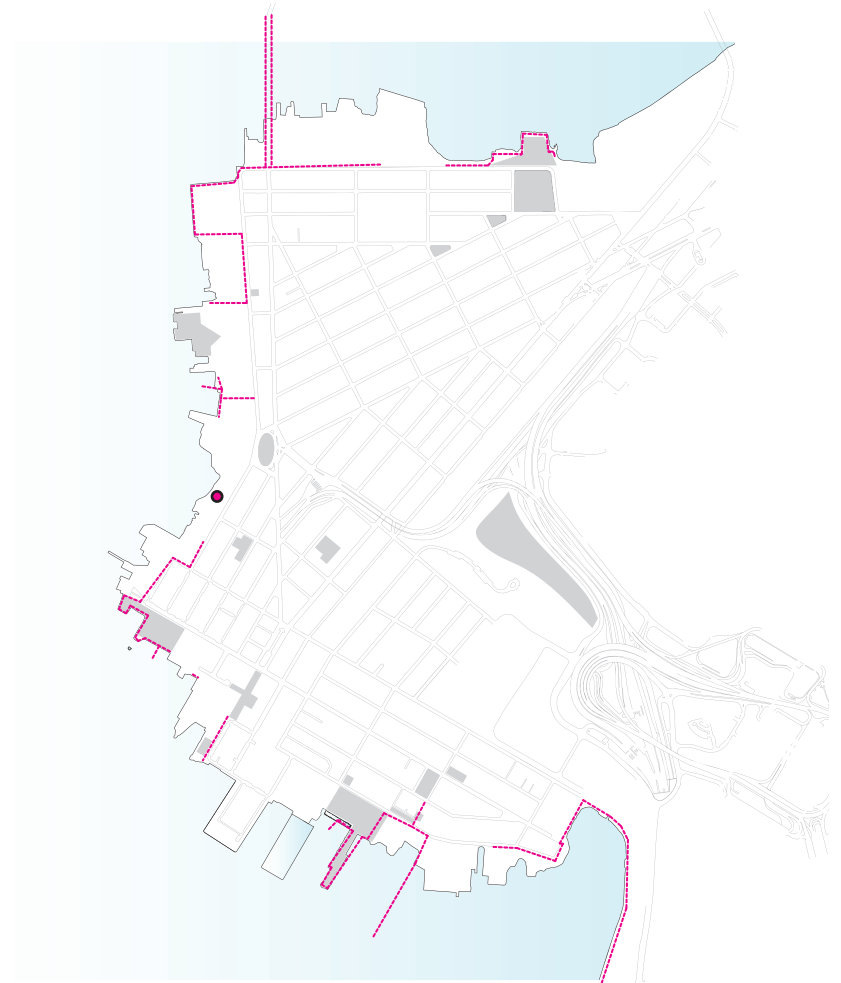
- Railroads
- Major Roads

Site Context





Developed Green Spaces






Harbor Walk Development

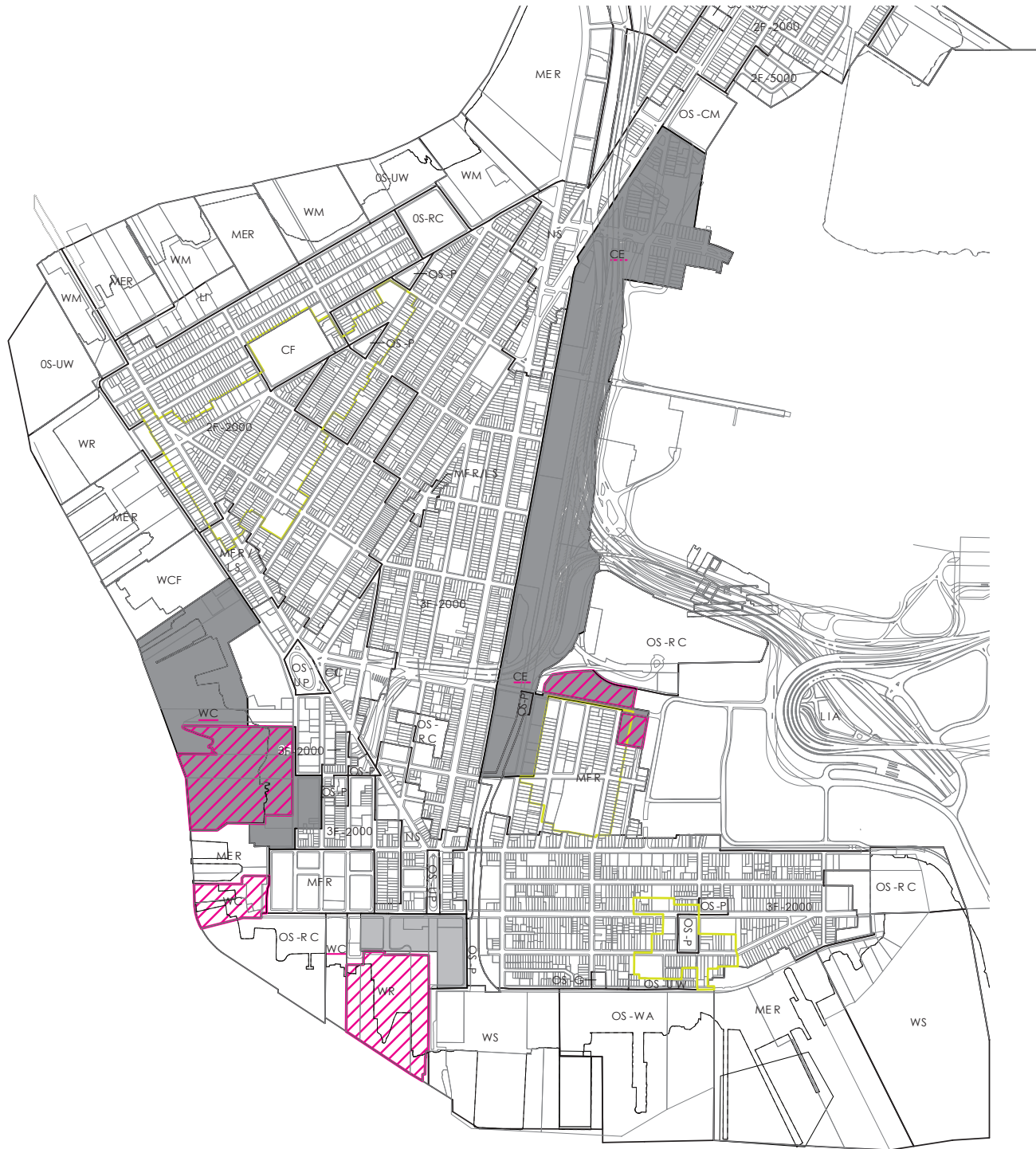
East Boston Program Use



- Residential
- Commercial
- Institutional
- Government
- Industrial

Zoning Map

1F	Residential Subdistricts
2F	One-Family Residential Subdistrict
3F	Two-Family Residential Subdistrict
MFR	Three-Family Residential Subdistrict
MFR / LS	Multifamily Residential Subdistrict
	Multifamily Residential / Local Services Subdistrict
CE	Corridor Enhancement Subdistrict
	Open Space Subdistricts
OS-CM	Cemetery Open Space District
OS-G	Community Garden Open Space Subdistrict
OS-P	Parkland Open Space District
OS-RC	Recreation Open Space District
OS-SL	Shoreland Open Space District
OS-UP	Urban Plaza Open Space District
OS-UW	Urban Wild Open Space District
OS-WA	Urban Wild Open Space District
	Neighborhood Business Subdistricts
NS	Neighborhood Shopping Subdistrict
CC	Community Commercial Subdistrict
LI	Local Industrial Subdistrict
LIA	Logan International Airport Subdistrict
CF	Community Facilities Subdistrict
EDA	Economic Development Area
	Waterfront Subdistricts
MER	Maritime Economy Reserve Subdistrict
WC	Waterfront Commercial Subdistrict
WCF	Waterfront Community Facility Subdistrict
WM	Waterfront Manufacturing Subdistrict
WR	Waterfront Residential Subdistrict
WS	Waterfront Service Subdistrict
	PDA Designation
	Urban Renewal Overlay District
	Special Study Overlay District
	Neighborhood Design Overlay District
	PDA Permitted



PROPOSAL

Programming

Site: 226,080 sq ft



Architecture

Center of Excellence for Sea Level Change and Resilience

Neighborhood Emergency or Evacuation Center
Offices
Community Space
Commercial
Soft Infrastructure System



Syracuse Center of Excellence

Syracuse, NY Offices, Classrooms and Materials Testing Laboratories

55,000 Square Feet

Landscape

Public Waterfront Landscape

Harborwalk Development
Open Green Space
Soft Infrastructure System



Harborwalk in Boston's Innovative District

Infrastructure

MBTA Ferry Terminal

Parking
Soft Infrastructure System



MBTA Hingham Ferry Terminal
12,767 Square Feet



Scale Diagrams



Surrounding Context



Building Footprint: 20,500 square feet
1 story



Building Footprint: 4,250 square feet
4 Stories



Building Footprint: 3,200 square feet
3 Stories



Building Footprint: 5,200 square feet
2 Stories

Proposed Program Site: 226,080 sq ft

Center of Excellence
50,000 - 60,000 square feet



Public Community Space
25,000 - 50,000 square feet



Parking
75,000 - 100,000 square feet



Ferry Terminal
8,000 - 14,000 square feet



Public Waterfront Green Space
75,000 square feet

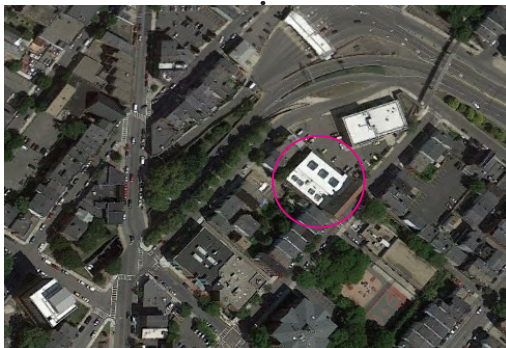


Evacuation Centers

An evacuation center is a facility at which citizens that need transportation during an evacuation will congregate. ¹ The center of excellence focused on sea level rise and resiliency will be programmed with community space that can double as an emergency shelter or evacuation center. There are currently only two neighborhood emergency centers in East Boston, one of which is an middle school and the other, a small community center. Ideally, evacuation centers should be close to public transportation.

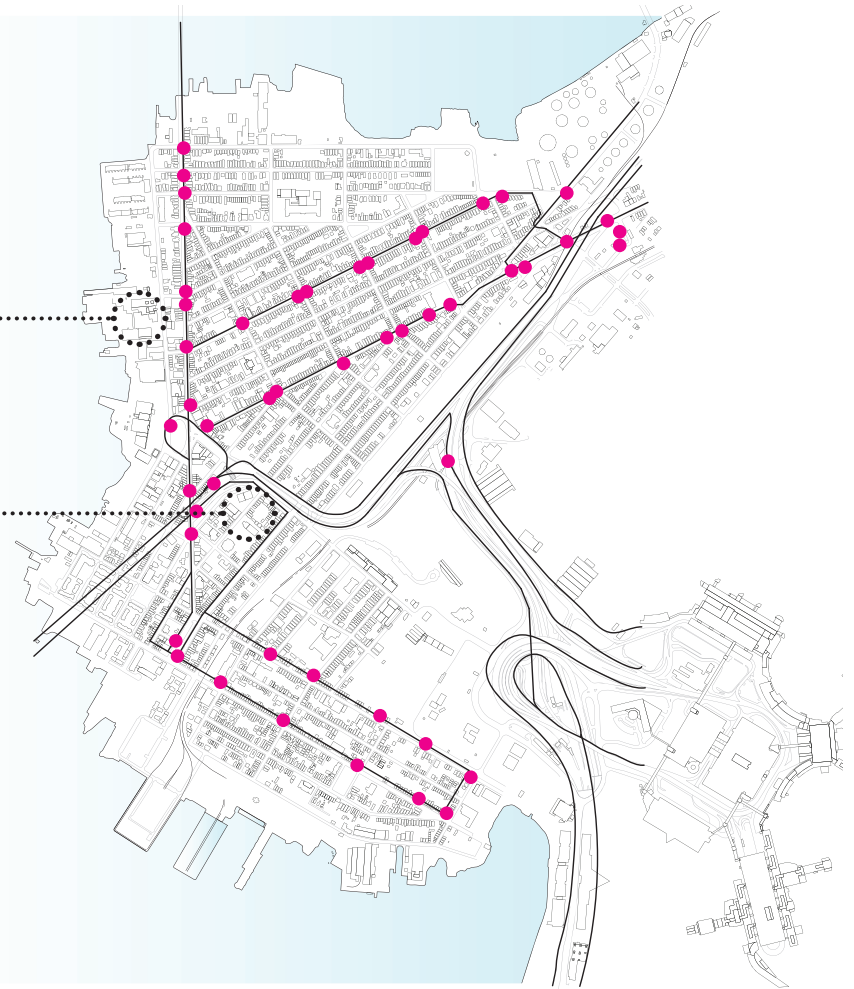


Umana Middle School Academy



Paris Street Community Center

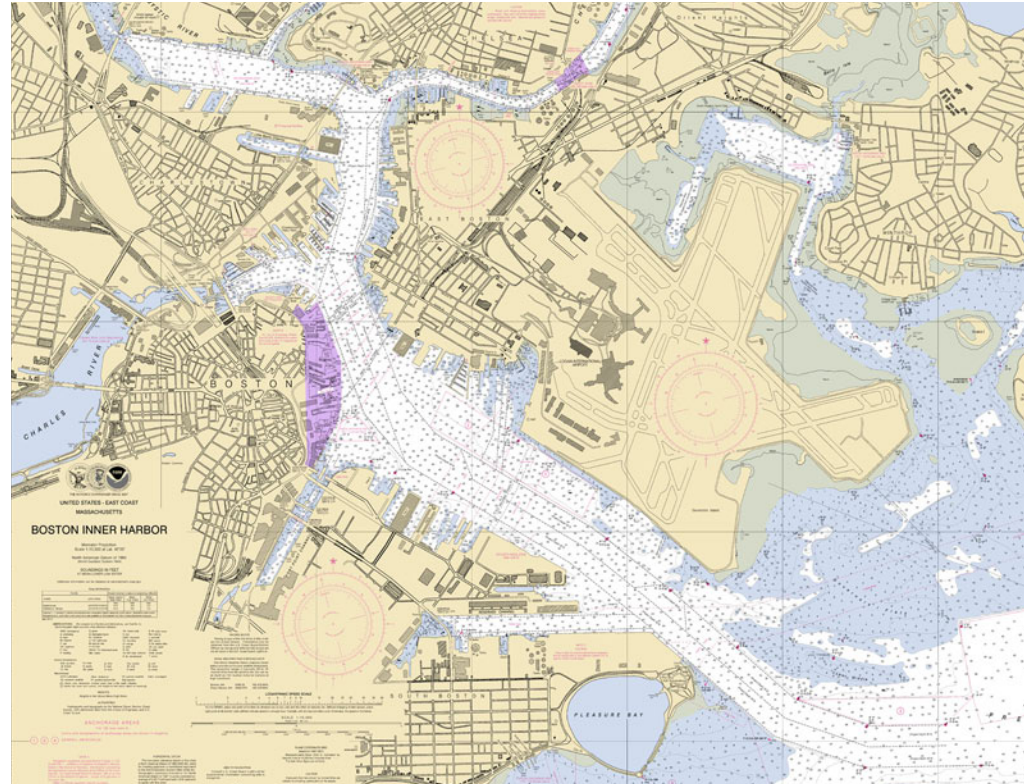
East Boston Neighborhood Emergency Centers

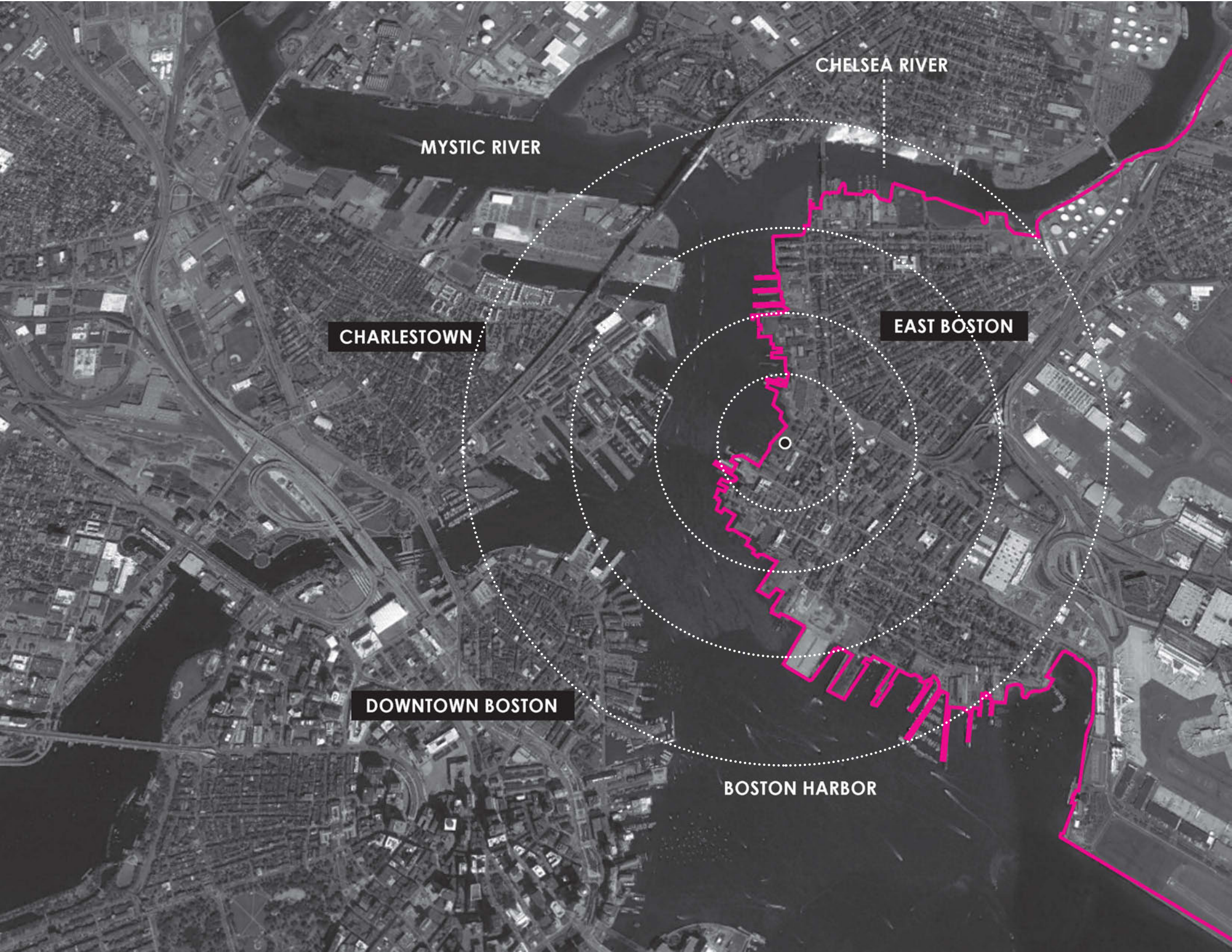


East Boston Public Transit

MBTA Ferry Terminals

The MBTA Ferry Terminal will be part of the waterfront and infrastructure component of the program, helping to activate the public landscape component. The ferry terminal builds upon the history of the site as a shipbuilding industry and takes advantage of the site's nautical possibilities. The Harborwalk network development that is currently being implemented along waterfronts to connect the entirety of the Boston Harbor waterfront will be enhanced, and the terminal will add to the one existing ferry stop in all of East Boston. The need for an emergency center to be located close to public transit will also be provided.





MYSTIC RIVER

CHELSEA RIVER

CHARLESTOWN

EAST BOSTON

DOWNTOWN BOSTON

BOSTON HARBOR

Waterfront Connection to Greater City of Boston



MBTA Ferry Terminals



Harborwalk Development







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Image Credits

Page 1

Davenport, Coral. "Rising Seas." The New York Times. The New York Times, 26 Mar. 2014. Web. 1 Sept. 2014. <http://www.nytimes.com/interactive/2014/03/27/world/climate-rising-seas.html?_r=0>.

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Image 3: How Beach Nourishment Projects Work.

Image 4: How Beach Nourishment Projects Work.

Image 5: How Beach Nourishment Projects Work.

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Image 1: "Working Together to Build a More Resilient Region." Rebuild by Design Working Together to Build a More Resilient Region Comments. N.p., n.d. Web. 16 Sept. 2014. <<http://www.rebuildbydesign.org/>>.

Image 2: Rebuild by Design.

Image 3: Rebuild by Design.

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Image 2: http://www.boston.com/yourtown_news_east_boston_2012_01_east_boston_residents_enthusia.html.png

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Image 4: Google Maps

